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FLUKE®

8200A
Digital Voltmeter

Instruction Manual

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Rev. 6/81

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Section 1

Introduction & Specifications

1-1. DESCRIPTION

1-2. The Model 8200A Digital Voltmeter (DVM) is a versatile instrument with four full decades of digits, plus a fifth digit for 60% overrange. The basic DVM will accept analog and/or system options and a number of accessories, that may be installed at the factory during manufacture or in the field at any time, in any sequence. These options and accessories expand the Model 8200A into a full systems multimeter capable of 400 readings per second. Table 1-1 lists the options and accessories.

Table 1-1. OPTIONS AND ACCESSORIES

OPTION NO.	NAME OF UNIT
8200A–01	AC Converter
8200A–02	MV Converter
8200A–03	Ohms Converter
8200A–04	**External Reference Input
8200A–05	Parallel Rear Input
8200A–06	* Printer Output
8200A–07	* Data Output
8200A–08	Remote Control
8200A–09	True RMS Converter

** 8200A–05 required with 8200A–04.

* 8200A–06 and 8200A–07 may not be installed in an instrument simultaneously.

ACCESSORY NO.	NAME
8200A-4017	PCB Extender Assembly (Required for servicing pcb's)
C82	Carrying Case
M03-200-607	Offset Rack Mount
M03-203-700	Dust Cover
80F-5	High Voltage Probe (5 kV)
80F-15	High Voltage Probe (15 kV)
80K-40	High Voltage Probe (40 kV)
80RF	High Frequency Probe (100 kHz to 500 MHz)
81 RF	High Frequency Probe (100 kHz to 100 MHz)
A90	Current Shunts, AC/DC

1-3. The operating instructions, theory of operation, and maintenance information for each option is described in the pertinent sections of this manual (Sections 2, 3, and 4). The accessories are fully described in Section 6.

1-4. Fluke's Recirculating-Remainder* Analog to Digital (A to D) conversion technique is used in the 8200A. This conversion circuitry periodically samples the input and serially digitizes the sample, providing a reliable DVM with high long-term accuracy and linearity plus superior environmental characteristics.

1-5. Basic DVM

1-6. The basic instrument measures dc voltages on four ranges with 100 microvolt resolution and 60% overranging. Standard features are switched filter, all-pushbutton selection and display, and thousand volt guarding. The digitized voltage is displayed on an in-line neon tube readout which includes polarity, overrange digit, and four full digit decades. Illuminated indicators designate the function called.

1-7. Pushbutton selection, full autoranging, instantaneous auto-polarity, and calibration of all standard and optional functions through the top guard cover are standard features of the Model 8200A.

1-8. Analog Options

1-9. The Millivolt option provides two measurement ranges of 10 and 100 millivolts displayed on five digits. This permits resolving 1 microvolt on the 10 millivolt range and 10 microvolts on the 100 millivolt range. Up to 400 switched readings per second may be taken on the 100 millivolt range and 10 readings per second on the 10 MV range. Autoranging between millivolt and dc ranges is standard,

* *Patent Pending*

with automatic MV to VDC function changeover and display. The switched filter may be used with the millivolt option.

1-10. AC voltage from 30 Hz to 100 kHz are measured on the four ranges of the AC option. Millivolt level ac voltages can be measured even though they are superimposed on a kilovolt of dc.

1-11. Up to 16 megohms of resistance can be measured using the Resistance option. Resolution at the low end is 10 milliohms. Full autoranging and Ω/KΩ/MΩ autofunctioning permit completely automatic measurement over the 10 milliohm to 16 megohm spectrum.

1-12. True four terminal, real-time ratio determinations may be obtained with the External Reference option. Four DC/DC ratio ranges are available when it is used with the basic 8200A. When Millivolts and AC Volts options are installed, MV/DC and AC/DC ratios can be measured.

1-13. Digital Options

1-14. The Printer Output option provides isolated and buffered data transfer for data logging systems. Grounded printers may be used without compromising any 8200A common mode specifications. Output is DTL/TTL compatible 8-4-2-1 BCD for parallel acquisition. The 8200A may be triggered up to 400 times a second via this option.

1-15. Isolated Data Output and Isolated Remote Control options make the 8200A a true systems DVM. They both operate with DTL/TTL levels, but Remote Control can also be exerted via contact closures. Each use guarded toroids for transfer of data from and to the 8200A. Both options are designed for multiplexing of remote control and data output on sets of lines common to a number of 8200A's.

1-16. Data may be acquired serially by character in multiples of four bits or completely in parallel. Automatic delays of data transfer can be single-line programmed to allow for settling time of the analog input prior to digitizing the data transferred. A speed of 400 readings per second is a further feature of the Data Output option.

1-17. Control commands can be applied to the Remote Control Unit and then removed, but the commanded functions and ranges will be retained in memory. Interlock logic prevents calling (selecting) incompatible functions or dual ranges simultaneously.

1-18. Outline Drawing

1-19. The Model 8200A Outline Drawing is shown in Figure 1-1.

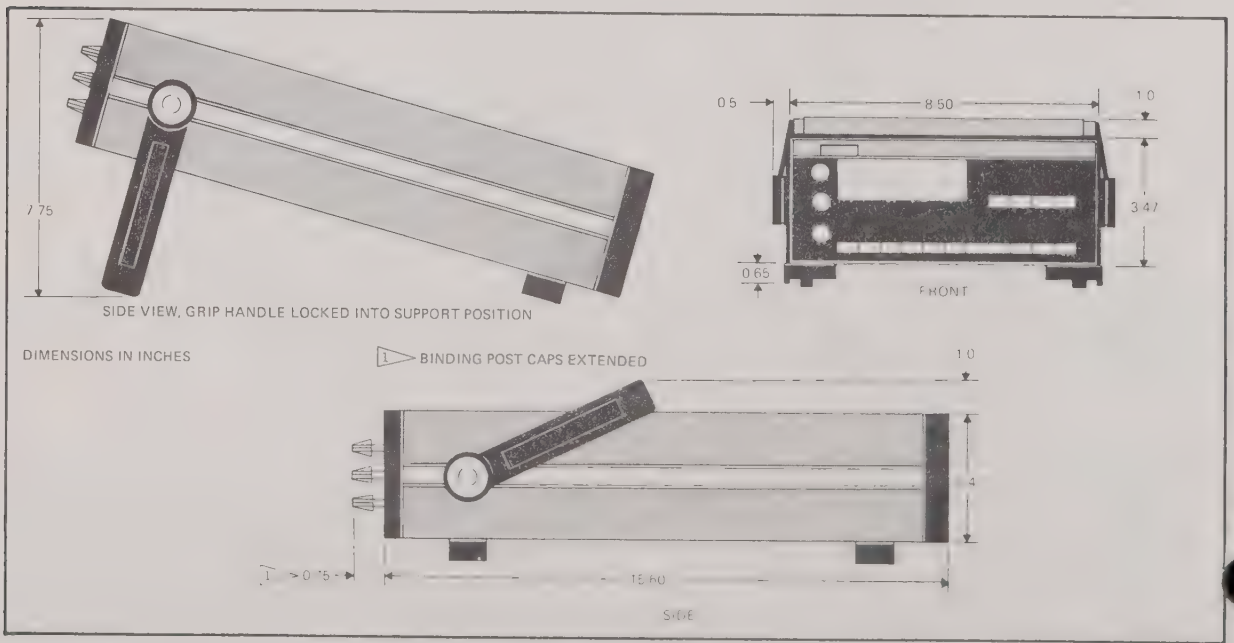

Figure 1-1. MODEL 8200A OUTLINE DRAWING

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1-20. SPECIFICATIONS

1-21. DC VOLTS

RANGES . . . . . ±1V, ±10V, ±100V, ±1000V (automatic polarity selection)

Resolution . . . . . 0.01% of range, (100 uv, maximum on ±1V range)
Overrange . . . . . 60%, (± 1200V maximum input on ±1000V range)
Overload (without damage) . . . . . ±1200V dc or 1100V rms continuously applied

ACCURACY (To 160% of range or ±1200V maximum input)

90 days, 18°C to 28°C . . . . . ± (0.01% of input +0.01% of range)
1 year, 18°C to 28°C . . . . . ± (0.02% of input +0.03% of range)

Temperature Coefficient
−10°C to 18°C and 28°C to 50°C . . . . . ±(0.001% of input +0.001% of range)/° C
Input Impedance, ±1V range . . . . . 10,000 megohms, minimum shunted by less than 130 p.F.
±10V to ±1000V ranges . . 10 megohms
Input Offset Current . . . . . Less than 50 pA.

NOISE REJECTION

Normal Mode[2], Filter "in" . . . . . Greater than 60 db @ 50 Hz increasing to greater than 65 dB @ 60 Hz and 100 dB @ 200 Hz and above.

Common Mode[1] [2]

DC to 60 Hz, Filter "in" (1k unbalance in either lead) Greater than 140 dB
Filter "out" (100Ω unbalance in either lead) Greater than 110 dB or one digit whichever is greater.

[1] *NOTE: Common Mode Rejection specifications are maintained with any combination of options installed and are unchanged with the use of grounded devices with the remote control, data output or printer output options.*

[2] *NOTE: The normal and common mode rejection are not line freqeuncy harmonic oriented due to the broad band response of an active 3-pole filter and therefore, will reject random noise at most frequencies.*

MAXIMUM SETTLING [3] (To a reading within 0.01% of range when measuring step change inputs and using external trigger)

Filter In . . . . . 2 ms
Filter Out . . . . . 2 seconds

[3] *NOTE: Requires a minimum of 1.75 milliseconds of digitizing time for a complete reading. See the timing diagram on the last page of this section. Note that the 2 milliseconds settling time can be placed between successive aperatures to achieve 400 readings per second when the time outs are disabled.*

1-22. GENERAL

A/D Conversion Technique . . . . . Recirculating—Remainder
Sample Aperature . . . . . 500 microseconds (at A/D converter input)
Sample Rate, External Trigger [4] . . . . . 400 readings per second maximum for all functions
Internal Trigger . . . . . 4 readings per second, basic DVM.
Autorange Time, (Per range change)
External Trigger [4] . . . . . 25 milliseconds: MV/VDC and Ω/KΩ/MΩ, Filter "out"
250 milliseconds all other combinations
Internal Trigger . . . . . 250 milliseconds

[4] *NOTE: External triggering is accomplished via Data Output or Printer Output Options.*

Filters . . . . . 4 pole active filter for dc volts, and resistance measurements, 3 pole active filter for millivolt measurements.
Range Selection . . . . . Manual, Automatic standard, Remote optional
Function Selection . . . . . Manual standard, Remote optional, Autorange MVDC/VDC, Ω/KΩ/MΩ
Function Annunciator . . . . . LED indicator for each function selected.

Display	In-line, neon-tube display of polarity, overrange digit and 4 full decades of digits with automatic decimal placement.
Overload Limits (Maximum voltage that may be continuously applied without damage)	
"Hi" to "Lo"	See individual functions under "range," "Overload."
"Lo" to "Guard"	±100V dc or peak ac. *NOTE: A protection circuit causes a warning lamp to illuminate when this limit is exceeded.*
"Guard" to "Chassis"	±1000V dc or peak ac, maximum common mode voltage for any function.
Temperature Range, Operating	−10°C to 50°C
Non-operating	−40°C to +75°C
Humidity Range, −10°C to 25°C	Less than 90% relative humidity
25°C to 50°C	Less than 80% relative humidity
Altitude Range, Operating	To 10,000 feet (3,048 km)
Non-operating	To 50,000 feet (15,24 km)
Shock and Vibration	Meets requirements of MIL-T-21200L and MIL-E-16400F
Operating Power	115/230V ±10%, 50 to 440 Hz, less than 25 W
Weight	Less than 15 pounds (7, 8kg) with all options
Size	3 - 1/2" H x 8 - 1/2" W x 15" D (88 mm x 216 mm x 381 mm)
Warm-up Time	20 minutes to 1 year accuracy, 1 hour to full accuracy

1-23. OPTIONS

1-24. DC MILLIVOLTS (Using Option 8200A−02)

RANGES . . . . . ±10 MV, ±100 MV with automatic polarity selection.

NOTE: Model 8200A autoranges between millivolts and dc volts.

Resolution	0.01% of range, (1 uv maximum on ±10 mv range)
Overrange	60%
Overload (to either range without damage)	
Fifteen seconds	±1200V dc or 1100V rms
Continuous	±300V dc or rms

ACCURACY (To 160% of range)

90 days, 18°C to 28°C	±100 MV range	±(0.01% of input +0.01% of range)
	±10 MV range	±(0.01% of input +0.02% of range)

Temperature Coefficient, −10°C to 18°C and 28°C to 50°C	
±100 MV range	±(0.0015% of input +0.002% of range)/°C
±10 MV range	0.02% of range/°C
Input Resistance	10,000 megohms minimum both ranges
Input Offset Current	Less than 10 pa

NOISE REJECTION

Normal Mode, Filter "in,"	±10 MV range	Greater than 75 db @ 50 Hz and greater than 80 db @ 60 Hz
	±100 MV range	Greater than 55 db @ 50 Hz and greater than 60 db @ 60 Hz

Common Mode (with up to 1K unbalance in either lead)

Filter "in,"	DC to 60 Hz	Greater than 180 db
Filter "out," (s)	DC	Greater than 180 db
	DC to 60 Hz	
	±10MV range	Greater than 140 db
	±100 MV range	Greater than 130 db

(s) *NOTE: With Filter out maximum "LO" to "GUARD" unbalance is 1 Ω*

MAXIMUM SETTLING TIME[6] (To a reading within 0.01% of range when measuring step change inputs and using external trigger).

Filter Out	
±100 MV range	2 ms
±10 MV range	100 ms
Filter In (both ranges)	2 sec.

[6] *NOTE: Requires a minimum of 1.75 milliseconds of digitizing time for a complete reading. See the timing diagram on the last page of this section.*

1-25. AC VOLTS (Using Option 8200A–01)

RANGES 1V, 10V, 100V, 1000V

Resolution	0.01% of range, (100 uv maximum on 1V range)
Overrange	60%, (1100V rms maximum input on 1000V range)
Overload (without damage)	1100V rms continuously applied to any range
Superimposed DC	±1100 VDC (Peak ac plus dc not to exceed ±1500V)

ACCURACY (To 160% of range or 1100V maximum input)

90 days, 18°C to 28°C

0.001V to 500 V

50 Hz - 20 KHz	±(0.1% of input +0.02% of range)
20 KHz - 50 KHz	±(0.2% of input +0.02% of range)
30 Hz - 50 Hz and 50 KHz - 100 KHz	±(0.5% of input +0.02% of range) [7]

500V to 1100V

50 Hz - 20 KHz	±0.15% of input
20 KHz - 50 KHz	±0.2% of input [7]
30 Hz - 50 Hz	±0.5% of input

[7] *NOTE: Input volt x hertz product should not exceed 2 x 10⁷.*

Temperature Coefficient	
–10° to 18°C and 28° to 50°C	±(0.004% of input +0.004% of range)/° C
Input Impedance	1.11 megohm, ±0.2%, shunted by less than 130 p.f.

NOISE REJECTION

Common Mode (With up to 100Ω unbalance in either lead)

DC to 60 Hz	Greater than 120 dB

MAXIMUM SETTLING TIME [8] 500 milliseconds to within 0.1%.

[8] *NOTE: Requires a minimum of 1.75 milliseconds of digitizing time for a complete reading. See the timing diagram on the last page of this section.*

1-26. TRUE RMS AC VOLTS (Using Option 8200A-09)

RANGES	1V, 10V, 100V, 1000V
Resolution	0.01% of range, (100 μV maximum on 1V range)
Overrange	60% (1100V rms maximum input on 1000V range)
Overload (without damage)	1100V rms continuously applied at any range (1500V peak AC)
Superimposed DC	±1100 VDC (Peak ac plus dc not to exceed ±1500V)
Crest Factor	7 at full scale, increasing downrange per $7X \frac{\text{V RANGE}}{\text{V INPUT}}$

ACCURACY ((To 160% of range or 1100V maximum input)

	Signal Frequency	AC + DC Mode	AC Only Mode
90 Days	DC	±(0.1% of input +0.04% of range)	
(18°C to 28°C) (10)	50 Hz - 10 kHz	±(0.2% of input + 0.04% of range)	±(0.1% of input + 0.02% of range)
(0.001V-1100V)(2)	10 kHz - 30 kHz (9)	±(0.2% of input + 0.06% of range)	±(0.2% of input + 0.04% of range)
	30 kHz-50 kHz (9)	±(0.3% of input + 0.12% of range)	±(0.3% of input + 0.1% of range)
	20 Hz - 50 Hz	±(0.5% of input + 0.04% of range)	±(0.5% of input + 0.02%of range)
	50 kHz - 100 kHz (9)	±(1% of input + 0.3% of range)	±(1% of input + 0.3% of range)
	100 kHz - 300 kHz (9)	±(2% of input + 0.5% of range)	±(2% of input + 0.5% of range)

(9) *NOTE: Input volt x hertz, product should not exceed 2 x 10^7*

(10) *NOTE: With inputs above 500V multiply accuracy by* $\frac{2000V + V\ input}{2000V}$

Temperature Coefficient (−10° to 18°C and 28°C to 50°C)

DC & 20 Hz - 10 kHz (AC + DC) . . . . . ±(0.005% if input ±0.004% of range)
20 Hz - 10 kHz (AC only) . . . . . ±(0.004% of 0.001% of range)
Input impedance . . . . . 1.0 megohm, shunted by less than 130 pF

NOISE REJECTION

Common Mode (With up to 100Ω unbalance in either lead)

DC to 60 Hz . . . . . Greater than 120 dB

MAXIMUM SETTLING TIME . . . . . 500 milliseconds to within 0.1% for reading greater than 10% of range. Double indicated time for readings less than 10% of range.

1-27. RESISTANCE (Using Option 8200A−03) (11)

RANGES . . . . . 100Ω, 1 KΩ, 10 KΩ, 100KΩ, 1000 KΩ, 10 MΩ

(11) *NOTE: Model 8200A will autorange through all resistance ranges*

Resolution . . . . . 0.01% of range, (10 milliohms maximum on 100Ω range)
Overrange . . . . . 60% on all ranges, (16 megohms maximum on 10 MΩ range)
Overload (without damage)
100Ω . . . . . 30V rms (fused - spare supplied)
1 KΩ − 10 MΩ) . . . . . 130V rms maximum (overloads in excess of 130V, to 1000V, will not damage any active circuit components)

ACCURACY (To 160% of range)

90 days, 18°C to 28°C	1 KΩ-100K	±(0.01% of input +0.01% of range)
	1000KΩ range . . .	±(0.02% of input +0.02% of range)
	100Ω range	±(0.03% of input +0.02% of range)
	10 MΩ rnage	±(0.1% of input +0.02% of range)

Temperature Coefficient (−10°C to 18°C and 28°C to 50°C)

100Ω	±(0.002% of input +0.001% of range)
1 KΩ – 100 KΩ ranges	±(0.001% of input +0.001% of range)/°C
1000 KΩ ranges	±(0.005% of input +0.002% of range/°C
10 MΩ range	±(0.015% of input +0.01% of range)/°C

CONFIGURATION . . . . . Two terminal

Current through R measured	0.1 μa @ 10 MΩ increasing in decade steps to 10 ma @ 100Ω
Voltage across R measured	1.6 Volts at 160% of range
Open terminal voltage	+10V maximum

MAXIMUM SETTLING TIME [12] (To a reading within 0.01% of range when measuring step change inputs and using external trigger)

100Ω – 100 KΩ ranges	
Filter Out	2 ms
Filter In	500 ms (550 ms, on 100 K range)
1000 KΩ range	
Filter Out	4 ms
Filter In	1.2 sec.
10 MΩ range	
Filter Out	28.25 ms
Filter In	7.0 sec.

[12] *NOTE: Requires a minimum of 1.75 milliseconds of digitizing time for a complete reading. See the timing diagram on the last page of this section.*

1-28. ISOLATED EXTERNAL REFERENCE (Four Terminal DC/DC Ratio using Options 8200A–04 And 8200A–05)

REFERENCE INPUT

Range of Reference Voltage	+1V to +11V
Reference Input Resistance	1 megohm ±0.1%
Isolation Voltage Range	Isolation is maintained for reference and input commons difference voltage between +8V and −6V
Reference Input Overload	The absolute value of V reference plus the difference in potential of reference and input commons must not exceed 25V.

RANGES . . . . . ±0.1; 1, ±1.0:1, ±10:1, ±100:1

NOTE: When the Millivolts option (8200A–02) is installed, the ratio capability of the 8200A is extended to include Ranges of ±0.001:1 and ±0.01:1 with full Autoranging from the ±0.001:1 Range through to the ±100:1 Range.

Resolution	0.01% of ratio, (0.00001:1 maximum on 0.1:1 range)
Overrange[13]	60%, (±1200V maximum input on the ±100:1 range)
Overload (without damage)	±1200V dc or 1100V rms continuously applied
Reading vs Ratio	10 x ratio

[13] *NOTE:* $\frac{\%\ Input\ +Voltage\ Range}{\%\ Reference\ Voltage\ Range}$ *must be less than 1-6 for a non-overrange reading. (10 volts is 100% of Reference Voltage Range).*

ACCURACY

90 Days, 18°C to 28°C	±(0.01% of input +0.01% x 10V/V_{ref} of range)
Temperature Coefficient	Same ad DV Volts multiplied by 10V/V_{ref}

NOISE REJECTION (At Reference Input)

Normal Mode	25 dB @ 60 Hz
Common Mode (With up to 1k unbalance)	80 dB with +10V reference

REFERENCE SETTLING TIME . . . . . 1 second maximum to 0.01% of ratio range for a step change of reference voltage.

1-29. ISOLATED PRINTER OUTPUT (P.O.U.) [14] (Option 8200A–06)

[14] *NOTE: Mating connector is supplied.*

Data Available	Digits, polarity, range
Coding	8421 BCD digits and range
Logic levels	1 = +5V, 0 = 0V (Series 930 DTL with 6k pull up–
Maximum Trigger Rate	400 per second (Timeout disabled mode diagram on last page of the section applies)

1-30. ISOLATED DATA OUTPUT (D.O.U.)[15](Option 8200A–07)

[15] *NOTE: Two mating connectors are supplied.*

Data Available	Digits, polarity, range, functions
Coding	8421 BCD, digits snd range
Logic Levels	1 = +5V, 0 = 0V (Series 930 DTL with 6k pull up)
Maximum Trigger Rate	400 per second
Flags	Ready, overload
Acquisition	Full parallel or serial by character in multiples of 4 bits
Automatic Adaptive Timeouts	Automatic delays to allow for settling time of all analog inputs are enabled via a single logic input line.

* *See Table 1-2 for timing information*

1-31. ISOLATED REMOTE CONTROL (R.C.U.) [16] (Option 8200A–08)

[16] *NOTE: Mating connector is supplied.*

Controls Levels	0 = function called, 1 = function inactive
Logic Levels	0 = contact closure or 0V, 1 = open or +5V
Input Definition	Series 930 DTL
Control Command Storage	Continuous or addressed remote control of instrument. Triggered address control allows the 8200A to "latch" tin input commands. Following latch, the commands may be removed but the functions and ranges commanded will continue to be in effect until the next address trigger.
Interlocks	Incompatible functions or simultaneous ranges cannot be called.
No Call	Volts DC and autorange called
Flag	+5V through 6 kΩ when the Remote button is depressed.

[16] *NOTE: Remote control unit requires a +5 V power (105 mA) from either Data Output Unit or an external power supply which can be supplied as a special item. Contact factory for further details.*

1-32. REAR INPUT [17] [18](Option 8200A–05) Rear input in parallel with front via 5 pin connector, mating connector supplied.

[17] *NOTE: This option increases the specified input capacitance by less than 75 p.f.*

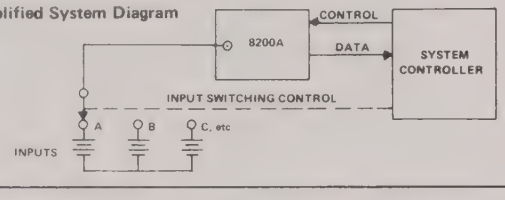
[18] *NOTE: Rear input is required for use with Option 8200A –04*

Table 1-2. DOU TIMING.

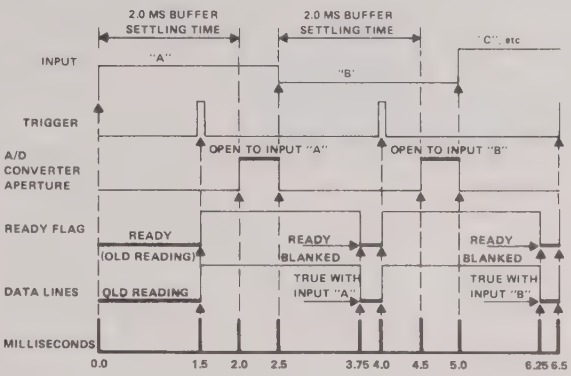
TIMEOUT DISABLED MODE

The unique Fluke Recirculating Remainder A-to-D conversion technique permits the 8200A to maintain its 400 readings per second speed while measuring switched inputs. As the diagram below shows, the 2 ms settling time for 8200A's Buffer Amplifier used on the 100 MV – 1000V and 100Ω-100kΩ ranges (filter "OUT") can be timed to occur during the 2 milliseconds interval between the end of one "sample aperture" and the beginning of the next. The slower ranges and functions may also be sampled at 400 readings per second but may not be switched or be widely varying in amplitude.

Simplified System Diagram

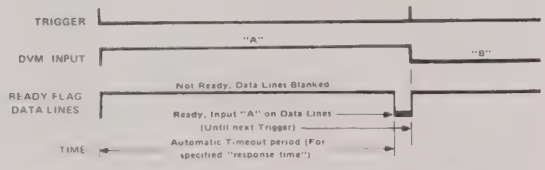


TIMING



TIMEOUT ENABLED MODE

Operation of the 8200A's D.O.U. in this mode provides a "Timeout" that prevents the 8200A from providing digital outputs until the specified input "response time" has elapsed. An external trigger initiates the delay whose duration is internally determined by the 8200A. At the conclusion of the delay, the 8200A automatically reads the settled input and transfers the reading to the Data Lines.



FUNCTION/RANGE (1)	TOTAL TIMEOUT MEASURED AT READY FLAG OUTPUT -ALL TIMES
VDC WITHOUT FILTER 1, 10, 100, 1000	15 MSEC
VDC WITH FILTER 1, 10, 100, 1000	530 MSEC
MVDC WITHOUT FILTER 10, 100	120 MSEC
MVDC WITH FILTER 10, 100	2.1 SEC
VAC 1, 10, 100, 1000	850 MSEC
Ω WITHOUT FILTER 100	17 MSEC
Ω WITH FILTER 100	560 MSEC
kΩ WITHOUT FILTER 1, 10, 100, 1000	17 MSEC
KΩ WITH FILTER 1, 10, 100, 1000	1.3 SEC
10 MΩ WITHOUT FILTER	45 MSEC
10 MΩ WITH FILTER	7.4 SEC
RANGE CHANGES ADD TO TIMEOUTS	
VDC, MVDC, Ω, KΩ, MΩ WITHOUT FILTER CALLED	20 MSEC/RANGE CHANGE
ALL OTHER CONDITIONS	250 MSEC/RANGE CHANGE

(1) A timeout is not provided for the 1.0 second setting time at the External Reference input.

SERIAL OUTPUT CAPACITY

Data on the output lines is normally present in parallel. However, parallel bit, serial-character data transfer in multiples of four bits, is achieved by appropriate addressing of eight D. O. U. control lines.

Figure A indicates how independent addressing of these lines can provide all data on only four lines to simplify the interface required for ASCII formating or card punch operation.

Figure B illustrates grouped addressing of the control lines to serially provide a computer with all 8200A data on two sixteen bit words.

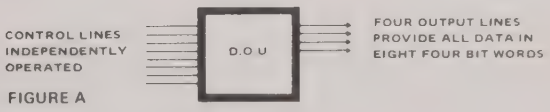


FIGURE A

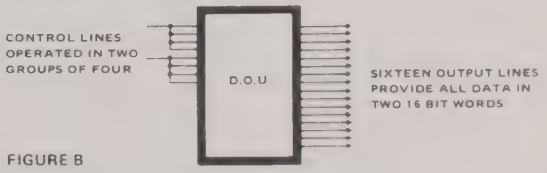
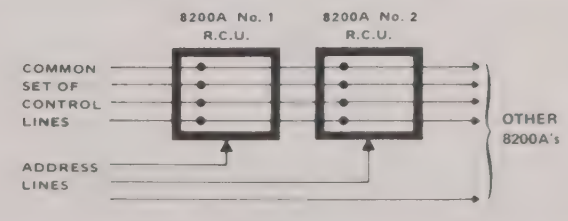


FIGURE B

MULTIPLEXED REMOTE CONTROL CAPACITY

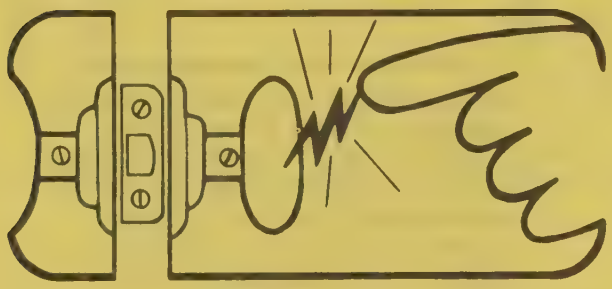
The "control command storage" mode of operation permits several 8200A's to be controlled via a common set of 12 lines. The simplified diagram indicates how address lines are used to route the commands into the appropriate DVM's R. C. U. The command is entered when the address line is energized and ignored when the address line is de-energized.



static awareness

A Message From

John Fluke Mfg. Co., Inc.

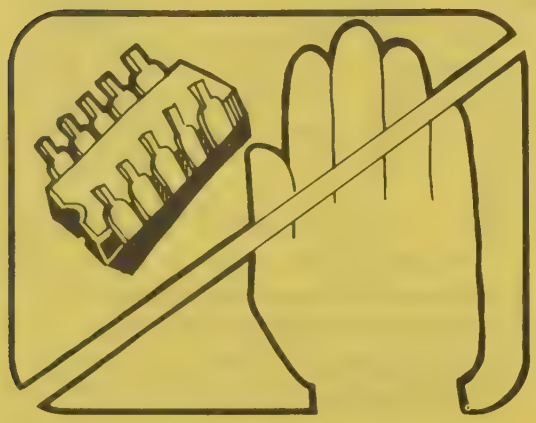


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

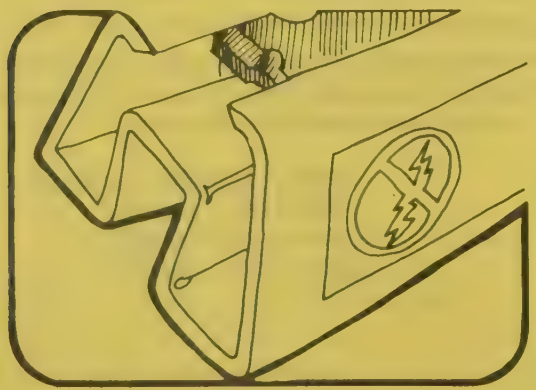
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗"

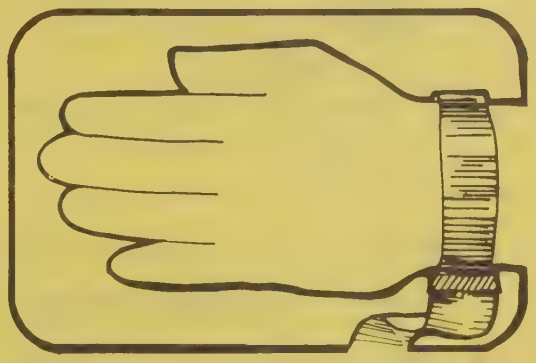
The following practices should be followed to minimize damage to S.S. devices.



1. MINIMIZE HANDLING

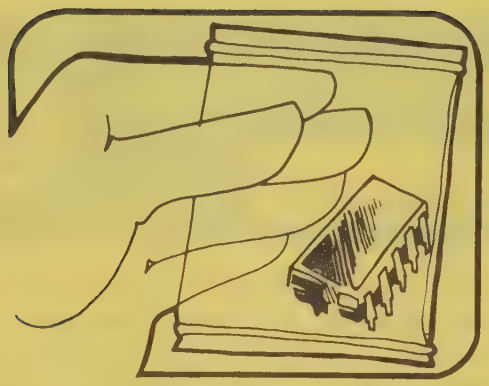


2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.

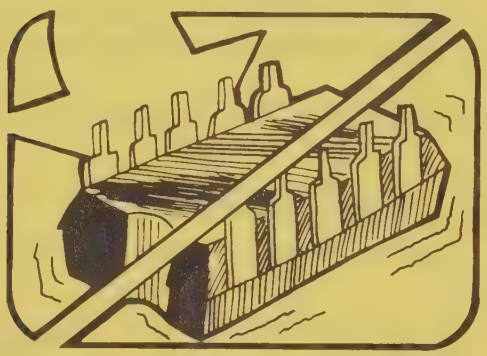


3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.

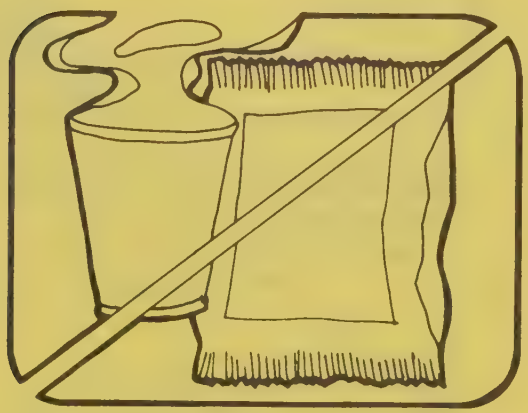
4. HANDLE S.S. DEVICES BY THE BODY



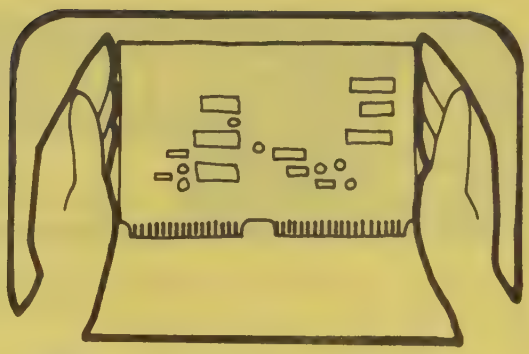
5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT



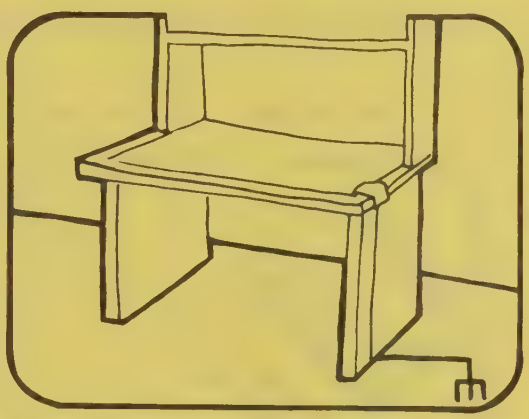
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS TO PROTECT INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION
10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.
11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

A complete line of static shielding bags and accessories is available from Fluke Parts Department, Telephone 800-526-4731 or write to:

JOHN FLUKE MFG. CO., INC.
PARTS DEPT. M/S 86
9028 EVERGREEN WAY
EVERETT, WA 98204

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Section 2

Operating Instructions

2-1. INTRODUCTION

2-2. This section contains information regarding installation and operation of the Model 8200A. It is recommended that the contents of this section be thoroughly read and understood before any attempt is made to operate this digital voltmeter. Should any difficulties be encountered during operation, please contact your nearest John Fluke Sales Representative or the John Fluke Mfg. Co., Inc., P.O. Box 7428, Seattle, Washington 98133, telephone (206) 774-2211. A list of Sales Representatives is located at the rear of this manual.

2-3. SHIPPING INFORMATION

2-4. The Model 8200A was packaged and shipped in a foam packed cardboard carton. Upon receipt, a thorough inspection should be performed to reveal any damage in transient. Special instructions for inspection and claims are included in the carton.

2-5. If reshipment of this digital voltmeter is necessary, the original container should be used. If the original container is not available, a new one can be obtained from the John Fluke Mfg. Co., Inc. Please reference the Model number when requesting a new shipping container.

2-6. INPUT POWER

2-7. The 8200A operates on 115 or 230 volt, 50 Hz to 440 Hz, ac power. Before applying power to the instrument, note the position of the 115/230 volt slide switch on the transformer switch bracket at the rear of the instrument. This switch is accessible after removing the top covers. If the switch does not indicate the desired operating voltage, place it in the correct position.

WARNING!

Ensure that the instrument is connected to a high quality earth ground through the polarized line plug.

2-8. RACK INSTALLATION

2-9. The 8200A is supplied with non-marring feet and tilt-down bail for bench or field use. Rack mounting kits for installation of the instrument in a standard 19-inch rack are available. These accessories are described in Section 6.

2-10. When the Model 8200A is rack mounted in initimate contact with other equipment above and below it, sufficient clearance must be provided as shown in Figure 2-1. When this clearance cannot be provided, and when the adjacent equipment above and below the 8200A are dissipating heat, a cooling fan is recommended. A cooling fan accessory kit can be installed at the factory during manufacture or in the field, as desired. The field installation kit can be obtained by ordering JF part number 315655. Field installation instructions are included with the kit.

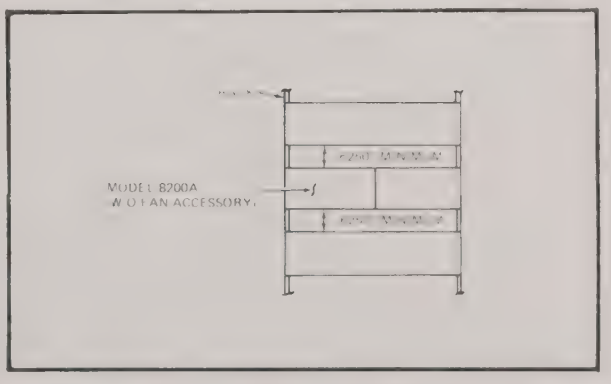
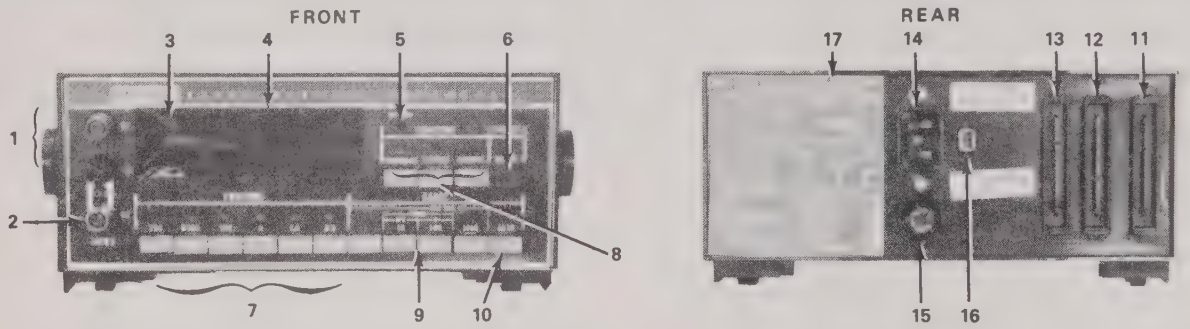


Figure 2-1. MODEL 8200A RACK MOUNT WITHOUT FAN ACCESSORY

2-11. OPERATING FEATURES

2-12. The name and function of front and rear panel controls, terminals and indicators are shown in Figure 2-1.



REF. NO.	NAME	FUNCTION
1	INPUT Terminals	HI, LO input connections for dc voltage, ac voltage, and resistance measurements
2	GD (guard) Terminal	Connects to internal guard chassis. When properly connected externally, provides maximum common mode rejection.
3	Polarity Indicator	Automatic indication of input polarity for dc voltage: "+" for positive input voltage and "–" for negative input voltages.
4	Readout Tubes	Display DVM readout from left to right, with overrange digit displayed in left-most tube. All tubes except overrange indicator display a decimal point, depending on range. Full overrange readout on each range would appear as follows: RANGE / READOUT 1 / 1.5999 10 / 15.999 100 / 159.99 1000 / 1599.9
5	MV ZERO Control (MV Converter Option only)	Adjusted for a readout of 0.000 ±1 digit with MVDC, FILTER, and 10 range called and INPUT terminals shorted with a low-thermal shorting link.
6	POWER Switch	Controls instrument input power.
7,8	FUNCTION Switches	Select desired DVM operating mode. Associated indicator lights indicate active function. VDC — Places DVM in dc voltage mode with full scale ranges of 1, 10, 100 and 1000. If no range is called, DVM will autorange and autofunction between MVDC and VDC. MVDC — Places DVM in dc millivolts mode with full scale ranges of 10 and 100. If unavailable range or no range is called, DVM will autorange and autofunction between MVDC and VDC.

Figure 2-2. CONTROLS, TERMINALS AND INDICATORS. (Sheet 1 of 2)

REF. NO.	NAME	FUNCTION
		VAC — Places DVM in ac voltage mode with full scale ranges of 1, 10, 100 and 1000. Ω — Places DVM in ohms mode with full scale range of 100. If unavailable range or no range is called, DVM will autorange and autofunction between Ω, KΩ and MΩ. KΩ — Places DVM in kilohms mode with full scale ranges of 1, 10, 100 and 1000. If no range is called, DVM will autorange and autofunction between Ω, KΩ and MΩ. MΩ — Places DVM in megohms mode with a full scale range of 10. If unavailable range or no range is called, DVM will autorange and autofunction between Ω, KΩ and MΩ. * FILTER — Controls 4-pole active input filter to provide noise rejection. Functional for dc volts, dc millivolts (3-pole only for millivolts) and resistance measurements. EXT REF — Enables substitution of isolated external reference voltage for DVM internal reference voltage. REMOTE — Places DVM in remote mode, enabling DVM function and range to be controlled remotely via optional Remote Control Unit.
9	Manual RANGE Switches	Permit manual selection of DVM range. Unselected range or incorrect range selection automatically places DVM in autorange mode.
10	AUTO RANGE Switch	Places DVM in autorange mode, providing automatic ranging for each function and its range complement.
11	Data Output Connector (No. 2)	Provides connections for Data Output Unit (Option 8200A–07).
12	Data Output Connector (No. 1) or Printer Output Connector	Provides connections for Data Output Unit (Option 8200A–07) or Printer Output Unit (Option 8200A–06).
13	Remote Control Connector	Provides connections for Remote Control Unit (Option 8200A–08).
14	AC Line Voltage Connector	Mates with polarized 3-wire power cord for connection to 115/230 volt, 50 Hz to 440 Hz, ac line.
15	Line Fuse	Protects DVM from overloads. Fuse rating is AGC 1/2A. Same fuse is used for 115V/230V operation.
16	Rear Input Connector	REAR ANALOG CONNECTION — Rear Analog Connector provides connections for External Reference Input and Parallel Rear Input (Options 8200A–04 and –05).
17	115/230 Volt Switch	Selects either 115V or 230V operation. Located on transformer bracket at rear of instrument: accessible after removing top dust cover.

* *NOTE: Marked FILT RMS to enable dc coupling (depressed) or ac coupling (released when the True RMS converter (–09 Option) is installed.*

Figure 2-2. CONTROLS, TERMINALS AND INDICATORS. (Sheet 2 of 2)

2-13. OPERATING NOTES

2-14. Overload Protection

2-15. The 8200A is protected against overload in each function and on all ranges. Table 2-1 lists the maximum voltages that may safely be applied to the DVM.

2-16. Guarded Measurements

2-17. The 8200A employs a system of shields and guards that functions to minimize unwanted signals and induced noise, thereby providing the user with a versitile systems DVM capable of fully-floated measurements without significant degradation.

2-18. Non-floated measurements are the usual case. Under these conditions, strap the front panel GD (guard) terminal to the LO input terminal using the shorting link provided.

2-19. In general, guarded voltage and resistance measurements will be necessary under the following conditions:

a. When long signal leads are used and signal source impedance is high.

b. When the DVM is operating in the presence of high-level radiated noise: The most common example is stray fields at the power line frequency.

c. When floated measurements are made and unwanted signals induced from high potential and/or high frequency common mode voltages are present.

2-20. Figure 2-3 shows two connection configurations that use guarded inputs during voltage measurements to reduce unwanted signals that are generated by common to normal mode signal conversion. When making unfiltered measurements in MVDC mode, connect the GD (guard) terminal connects to the LO input terminal to reduce the influence of internally generated noise.

2-21. The shorting link between the "LO" and "GD" terminals should not be removed unless guarded measurements are made. Typical connections for guarded measurements are shown in Figure 2-4 . Although the maximum potential difference between the "LO" and "TERMINALS" is specified as ±100V peak, protection against damage is provided to 115V rms. An illuminated indicator glows in the 8200A's visual readout when the protection circuit operates.

Table 2-1. OVERLOAD PROTECTION CHARACTERISTICS

FUNCTION	MAXIMUM SAFE INPUT	FORM OF PROTECTION
VDC	±1200V dc or 1100V rms (± 1500V peak) continuously on any range.	Circuit Design
MVDC (-02 OPTION)	±1200V dc or 1100V rms for 15 seconds on either range. * ±300V dc or rms continuously on either range. *	
VAC (-01 Option) or VRMS (-09 Option)	1100V rms continuously on any range ±1100V dc (peak ac plus dc may not exceed ±1500V).	
Ω (–03 OPTION)	20V rms	Fuse: 100 mA fuse, with spare, located on Ohms Converter pcb.
KΩ, MΩ (-03 OPTION)	130V rms *	
EXT REF (–04 OPTION)	$V_{ER} + V_{CM}$ not to exceed 25 volts where V_{ER} is External Reference input voltage and V_{CM} is voltage between External Reference Input common and Instrument Input Common.	Circuit Design
Any	Overload limit "LO" to "GD" (Guard) is ±100V dc or peak ac.	A protection circuit causes an internal warning lamp to illuminate when this limit is exceeded. Lamp is visible through front panel display window.

* When this maximum safe limit is exceeded, but input is less than ±1200V dc or 1100V rms, damage will be limited to an input resistor on millivolts board or range resistor on ohms board. Overloads in excess of 130V to 1000V cannot damage any active circuits.

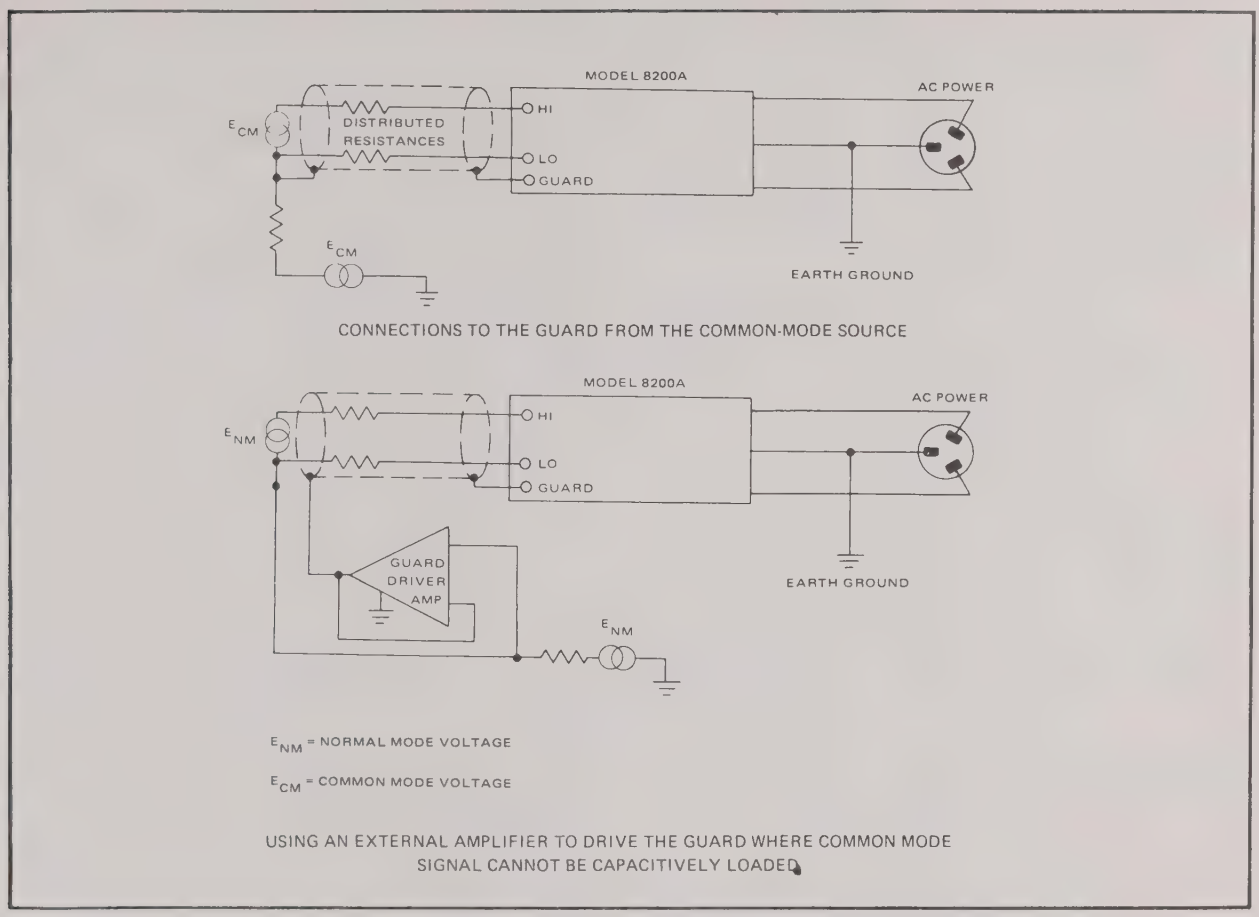


Figure 2-3. SUGGESTED GUARD CONNECTIONS FOR REDUCTION OF COMMON MODE - TO - NORMAL MODE SIGNAL CONVERSION

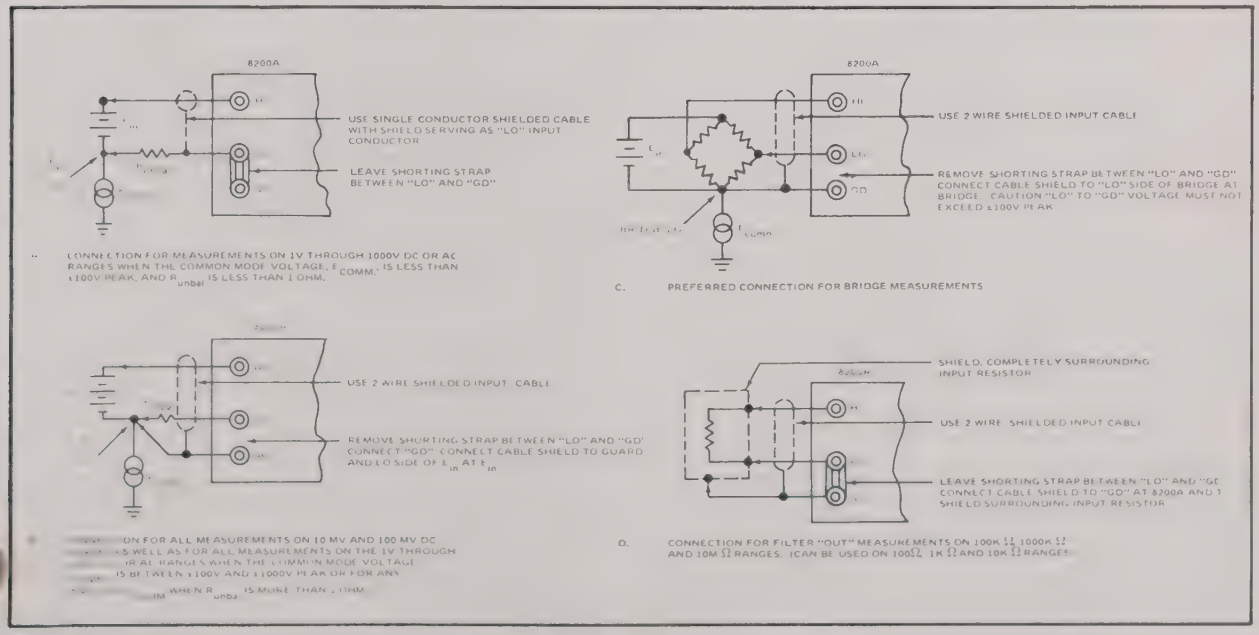

8200A
USE SINGLE CONDUCTOR SHIELDED CABLE WITH SHIELD SERVING AS "LO" INPUT CONDUCTOR
LEAVE SHORTING STRAP BETWEEN "LO" AND "GD"
CONNECTION FOR MEASUREMENTS ON 1V THROUGH 1000V DC OR AC RANGES WHEN THE COMMON MODE VOLTAGE, $E_{COMM.}$, IS LESS THAN ±100V PEAK, AND R_{unbal} IS LESS THAN 1 OHM.
8200A
USE 2 WIRE SHIELDED INPUT CABLE
REMOVE SHORTING STRAP BETWEEN "LO" AND "GD" CONNECT CABLE SHIELD TO "LO" SIDE OF BRIDGE AT BRIDGE. CAUTION "LO" TO "GD" VOLTAGE MUST NOT EXCEED ±100V PEAK
C. PREFERRED CONNECTION FOR BRIDGE MEASUREMENTS
USE 2 WIRE SHIELDED INPUT CABLE
REMOVE SHORTING STRAP BETWEEN "LO" AND "GD" CONNECT "GD" CONNECT CABLE SHIELD TO GUARD AND LO SIDE OF E_{in} AT E_{in}
ON FOR ALL MEASUREMENTS ON 10 MV AND 100 MV DC AS WELL AS FOR ALL MEASUREMENTS ON THE 1V THROUGH IR AC RANGES WHEN THE COMMON MODE VOLTAGE IS BETWEEN ±100V AND ±1000V PEAK OR FOR ANY IM WHEN R_{unbal} IS MORE THAN 1 OHM.
SHIELD, COMPLETELY SURROUNDING INPUT RESISTOR
USE 2 WIRE SHIELDED INPUT CABLE
LEAVE SHORTING STRAP BETWEEN "LO" AND "GD" CONNECT CABLE SHIELD TO "GD" AT 8200A AND T SHIELD SURROUNDING INPUT RESISTOR
D. CONNECTION FOR FILTER "OUT" MEASUREMENTS ON 100K Ω, 1000K Ω AND 10M Ω RANGES. (CAN BE USED ON 100Ω, 1K Ω AND 10K Ω RANGES

Figure 2-4. TYPICAL GUARD CONNECTIONS

2-22. BASIC INSTRUMENT MEASUREMENT INSTRUCTIONS

2-23. Measurement instructions for the basic instrument (less Options) are given in Table 2-2. These instructions apply to only the dc volts capability.

Table 2-2. BASIC MEASUREMENT INSTRUCTIONS

MEASUREMENT	±DC VOLTS
FUNCTION	VDC
RANGE	1, 10, 100, 1000
INPUT CONNECTIONS	Front panel HI, LO terminals or rear input terminals if equipped with Parallel Rear Input option. Connect GD (guard) terminal as recommended in paragraph 2-16. Guarded Measurements.
REMARKS	DVM autoranges automatically if range is not manually selected. 60% overrange is standard.

2-24. ANALOG OPTION MEASUREMENT INSTRUCTIONS

2-25. Operation of the Model 8200A in an optional function is accomplished by first assuring that the required option is installed and then selecting the function via the front panel pushbutton switches. The following paragraphs describe the purpose of each analog option. Table 2-3 contains measurement instructions for analog options, except External Reference.

2-26. AC Converter (–01 Option)

(See Section 6 for the True RMS converter (–09 Option) operating and measurement instructions.

2-27. The A5 AC Converter provides an ac voltage measurement capability through four ranges of 1, 10, 100, and 1000 with a frequency range of 30 Hz to 100 kHz at 500V ac or less and 30 Hz to 50 kHz at 500V ac to 1100V ac. Installation instructions for the AC Converter are covered in Section 6.

2-28. MV Converter (–02 Option)

2-29. The A3 MV Converter provides a dc voltage measuring capability through two ranges of 10 and 100 millivolts with a resolution of 1 microvolt in the 10 millivolt range and 10 microvolts in the 100 millivolt range. Installation instructions for the MV Converter are covered in Section 6.

2-30. Ohms Converter (–03 Option)

2-31. The A2 Ohms Converter provides resistance measuring capability in six ranges of 100Ω, 1k Ω, 10k Ω, 100k Ω, 1000k Ω, and 10M Ω. Full autoranging plus autofunctioning between Ω, kΩ, and MΩ, permit complete automatic measurement capabilities. Installation instructions for the Ohms Converter are covered in Section 6.

2-32. External Reference (–04 Option)

3-33. The A11 External Reference Unit option enables substitution of an external dc voltage for the internal DVM reference voltage. The principal use of the instrument when operated in this manner is for voltage ratio measurements. Another important use is to allow substitution of a system voltage for the 8200A reference voltage, whereby variables in systems measurements may be reduced.

Table 2-3. ANALOG OPTION MEASUREMENT INSTRUCTIONS

MEASUREMENT	FUNCTION	RANGE	INPUT CONNECTIONS	REMARKS
AC VOLTS (–01 Option)	VAC	1, 10, 100 1000	Front panel HI, LO terminals or rear input terminals if equipped with Parallel Rear Input option. Connect GD (guard) terminal as recommended in paragraph 2-16. Guarded Measurements.	DVM autoranges automatically if range is not manually selected or if selected range is not available. (Example: 1 MVDC) DVM autofunctions between MVDC and VDC and between Ω, KΩ and MΩ if unavailable range is selected. (Example: 1000 MΩ) 60% overrange is standard for all functions.
± DC Millivolts (–02 Option)	MVDC	10, 100		
Ohms (–03 Option)	Ω	100		
Kilohms (–03 Option)	KΩ	1, 10, 100, 1000		
Megohms (–03 Option)	MΩ	10		
MV Zero Adjustment (For MV Option)	MVDC, FILTER	10	Short INPUT terminals together with low-thermal shorting link.	Adjust front panel MV ZERO control for readout of 0.000 ±1 digit.

2-34. The External Reference Unit enables 4-terminal voltage ratio measurements: ±dc to dc, ±mV to dc, and ac to dc. A rear panel input connector is provided for reference voltage input. The connector is shown in Figure 2-5.

2-35. OPERATION.

2-36. The following steps describe the basic operating procedure for ratio measurements:

a. Select the 8200A voltage range as desired according to the ratio range and corresponding readout shown in Table 2-4.

b. Connect reference voltage to rear input terminals.

c. Press EXT REF switch on front panel.

d. Press VDC or MVDC switch if dc/mV to dc voltage ratios are to be measured or VAC switch if ac to dc ratios are to be measured.

2-37. Installation instructions for External Reference Unit are covered in Section 6.

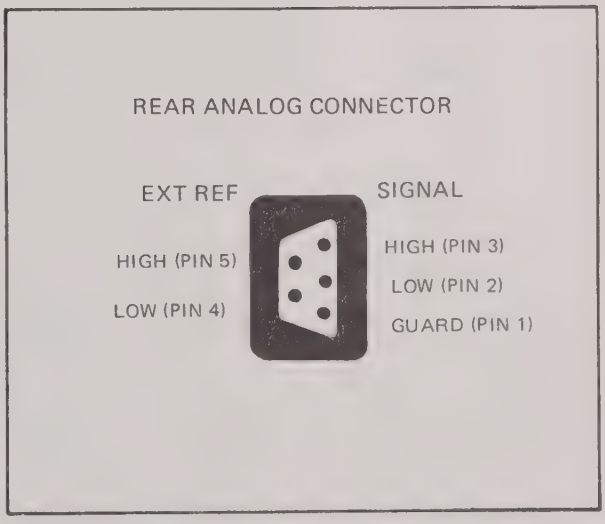


Figure 2-5. REAR CONNECTOR

2-38. Rear Input (–05 Option)

2-39. The Rear Input option enables the application of input connections at the rear panel of the Model 8200A. The operation of the Model 8200A with this option installed is the same as the operation through the front panel terminals.

Table 2-4. EXTERNAL REFERENCE RATIO RANGES

MODE	DVM RANGE	RATIO RANGE $\left(\frac{V_{INPUT}}{V_{REF}}\right)$	READOUT	REFERENCE INPUT
DC/DC X 10	1	0 to ±0.15999	0 to ±1.5999	+2V to +11V into 1 MΩ Input Resistance
	10	0 to ±1.5999	0 to ±15.999	
	100	0 to ±15.999	0 to ±159.99	
	1000	0 to ±159.99	0 to ±1599.9 *	
MV/DC X 10	10	0 to ±1.5999	0 to ±15.999	
	100	0 to ±15.999	0 to ±159.99	
AC/DC X 10	1	0 to 0.15999	0 to 1.5999	
	10	0 to 1.5999	0 to 15.999	
	100	0 to 15.999	0 to 159.99	
	1000	0 to 159.99	0 to 1599.9 *	

* Maximum input voltage is ±1200V dc or 1100V rms.

2-40. Interface between the Rear Input connector and external equipment requires the use of a mating connector. This mating connector is available from FLUKE under PART NO. 321653. Installation information regarding this connector is located in Section 6.

2-41. DIGITAL OPTION OPERATING INSTRUCTIONS

2-42. Printer Output Unit (–06 Option)

2-43. GENERAL.

2-44. The A16 Printer Output Unit (POU) provides isolated and buffered data transfer for data logging systems. POU access is by means of a single edge card connector located at the rear of the instrument. See item 12 of Figure 1-1. Data may be acquired in parallel BCD format only.

2-45. The POU is self-powered and provides +5V output for operation of the Remote Control Unit (Option –08). POU truth tables and logic levels are given in Table 2-5. POU pin connections are shown in Figure 2-6. Functional pin connections for the POU are given in Table 2-6.

Table 2-5. PRINTER OUTPUT UNIT TRUTH TABLES AND LOGIC LEVELS

OUTPUTS	NO. OF LINES	OUTPUT LOGIC LEVELS	
		0 to +0.5V	+5V
Function Indicator	1		
4 Digits BCD 8-4-2-1	16		
Range (coded)	2		
RANGE: 1000 — LINE: a 1, b 1		Logic "0"	Logic "1"
RANGE: 100 — LINE: a 1, b 0			
RANGE: 10 — LINE: a 0, b 1			
RANGE: 1 — LINE: a 0, b 0			
Overrange Digit	1		
Polarity "+" = 0 "–" = 1	1		
Ready Flag	1	Ready	Not Ready
External Trigger or Autotriggering Inputs	1	Inhibit	Enable

2-46. CONTROL SIGNALS

2-47. POU control signals consist of External Trigger and Autotriggering. The external trigger may be a positive or negative going signal as shown in Figure 2-7. Autotriggering is disabled by application of a Logic "0" and enabled by application of Logic "1".

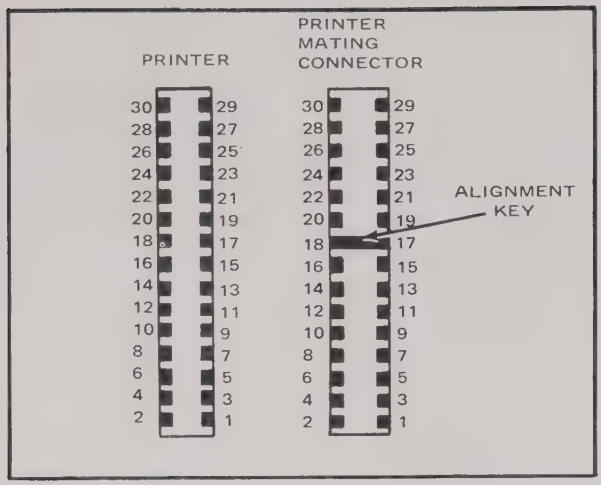


Figure 2-6. POU REAR PANEL CONNECTORS

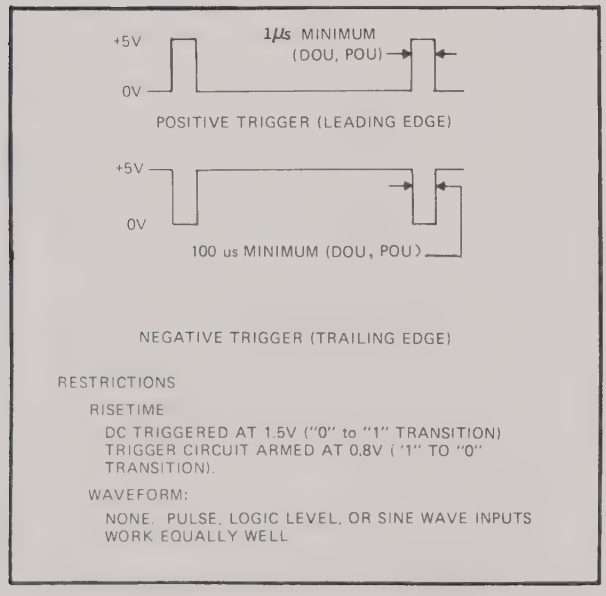


Figure 2-7. TRIGGER REQUIREMENTS

2-48. DATA ACQUISITION

2-49. Parallel data acquisition is accomplished by the following steps:

a. Acquire full digits data by connection to decade outputs.

Table 2-6. PRINTER OUTPUT UNIT FUNCTIONAL PIN CONNECTIONS

OUTPUT		PIN	TRUTH TABLE
FUNCTION INDICATION		12	1 = VDC OR VAC OR KILOHMS (KΩ) (SEE TABLE 2-7) 0 = MVDC OR OHMS (Ω) OR MEGOHMS (MΩ)
RANGE	a b	10 9	a b 0 0 = 1 a b 0 1 = 10 a b 1 0 = 100 a b 1 1 = 1000
POLARITY		27	1 = NEGATIVE 0 = POSITIVE
OVERRANGE "1"		10	1 = DECIMAL "1" 0 = DECIMAL "0"
FIRST DECADE (MSD)	a b c d	24 11 7 8	DECIMAL NUMBER BCD BIT 0 1 2 3 4 5 6 7 8 9 a 0 0 0 0 0 0 0 0 1 1 b 0 0 0 0 1 1 1 1 0 0 c 0 0 1 1 0 0 1 1 0 0 d 0 1 0 1 0 1 0 1 0 1 BIT WEIGHT: a = 8 b = 4 c = 2 d = 1
SECOND DECADE	a b c d	5 4 1 2	
THIRD DECADE	a b c d	23 21 22 19	
FOURTH DECADE (LSD)	a b c d	29 25 30 28	
AUTO-TRIGGER DISABLE		14	LOGIC 0 OR SHORT INHIBITS INTERNAL TRIGGER AND ENABLES 8200A TO ACCEPT EXTERNAL TRIGGER. LOGIC 1 OR OPEN ENABLES INTERNAL TRIGGER.
EXTERNAL TRIGGER INPUT		13	TRANSITION FROM LOGIC 0 TO LOGIC 1 COMMANDS 8200A TO READ.
READY FLAG		26	1 = NOT READY 0 = READY
+5V DC PWR SUPPLY EXT. GND OR COMMON		15 16	605 mA AVAILABLE CRCU REQUIRES 105 mA ISOLATED FROM INPUT LO AND CHASSIS
SPARE INVERTER		6 3	6 3
LOGIC "1" = +5V LOGIC "0" = 0 to +0.5V			

Table 2-7. PRINTER OUTPUT UNIT RANGE/FUNCTION INDICATOR CODING

FUNCTION PROGRAMMED	RANGE a	RANGE b	FUNCTION INDICATOR	FUNCTION CALLED	RANGE CALLED
VDC, MVDC	0	1	0	MVDC	10
VDC, MVDC	1	0	0	MVDC	100
VDC, MVDC	0	0	1	VDC	1
VDC, MVDC	0	1	1	VDC	10
VDC, MVDC	1	0	1	VDC	100
VDC, MVDC	1	1	1	VDC	1000
VAC	0	0	1	VAC	1
VAC	0	1	1	VAC	10
VAC	1	0	1	VAC	100
VAC	1	1	1	VAC	1000
Ω *	1	0	0	Ω	100
KΩ	1	0	0	Ω	100
KΩ	0	0	1	KΩ	1
KΩ	0	1	1	KΩ	10
KΩ	1	0	1	KΩ	100
KΩ	1	1	1	KΩ	1000
KΩ	0	1	0	MΩ	10
MΩ	0	1	0	MΩ	10

* When Ω or MΩ function is programmed, the range is automatically commanded.

b. Acquire function, range, overrange, and polarity data as desired.

c. Foregoing data could be grouped for presentation in several printer columns, with each column weighted as desired.

d. Acquire Ready Flag for use as desired.

2-50. Installation instructions for the Printer Output Unit are covered in Section 6.

2-51. Data Output Unit (–07 Option)

2-52. GENERAL

2-53. The A9 and A10 Data Output Unit (DOU) provides data output that is completely isolated from analog input and is available in 8-4-2-1 BCD logic level. DOU access is by means of two-edge card connectors located at the rear of the instrument. See item 12 in Figure 2-2. DOU pin connections are shown in Figure 2-8. Data may be acquired fully in parallel BCD format or serially by character in multiples of four bits. The Time-outs Enabled line activates automatic time delays that allow for full settling of analog input circuitry prior to data transfer.

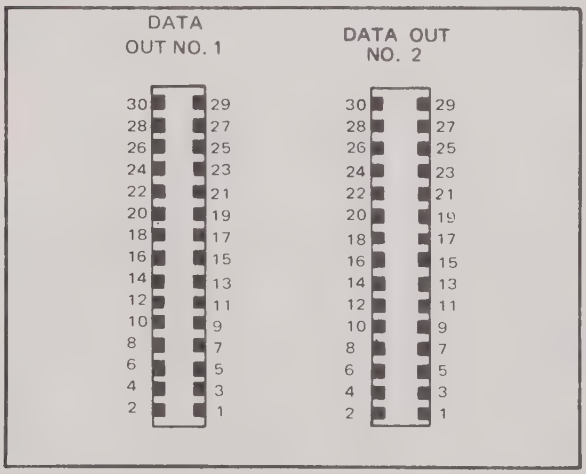


Figure 2-8. DOU REAR PANEL CONNECTORS

2-54. The DOU is self-powered and provides +5V output for operation of the Remote Control Unit (Option –08) plus an additional 500 milliamperes for operation of other logic circuitry. DOU truth tables and logic levels are given in Table 2-8. Functional pin connections for the DOU are given in Table 2-9.

2-55. The front panel display will change during the time-out period due to the DOU commanding the Model 8200A to sample the input during the time-out period. Logic

Table 2-8. DATA OUTPUT UNIT TRUTH TABLES AND LOGIC LEVELS

OUTPUTS	NO. OF LINES	OUTPUT LOGIC LEVELS	
		0 to +0.5V	+5V
Function VDC, MVDC, VAC, FILTER, Ω, KΩ, MΩ, EXT REF	8	Function inactive	Function operative at last sample
4 Digits, Binary-Coded Decimal 8-4-2-1	16	Logic 0	Logic 1
Polarity "+" = 0 "–" = 1	1		
Range (coded) RANGE / LINE a b 1000 1 1 100 1 0 10 0 1 1 0 0	2		
Overrange Digit	1		
Flags Overload Ready	2	No Overload Ready	Overload Not Ready
+5V and Common	5	- -	- -

INPUTS	NO. OF LINES	INPUT LOGIC LEVELS	
		0 to +0.5V	+5V
External Trigger	1	Inhibit	Enable
External Trigger Inhibit	1	Inhibit	Enable
Timeouts Enabled	1	Programmed timeouts (Normal)	Timeouts defeated (Fast)
Output Buffer Gate Control (Inhibit Lines)	8	Inhibit	Enable

circuitry in the DOU processes the readings obtained from these samples and determines whether the time-out should be continued or terminated. The DOU thus prevents the transfer of data until the buffer amplifier has fully settled with the input on the correct range if autoranging was used. Figure 2-9 shows the front panel change during the time-out period.

2-56. CONTROL SIGNALS

2-57. DOU control inputs consist of External Trigger, Autotriggering, and Timeouts Enabled. The External Trigger may be a positive or negative going signal as shown in Figure 2-7. Autotriggering is disabled by a Logic "0" and enabled by a Logic "1". The Timeouts Enabled input must be a Logic "1" to defeat the timeout period and a Logic "0" for normal operation with preprogrammed timeouts.

Table 2-9. DATA OUTPUT UNIT FUNCTIONAL PIN CONNECTIONS

LOGIC LEVELS: 0 = 0 to 0.5V
1 = 5V

DATA		DOU NO. 1 PIN NO.	
FIRST DECADE (MSD)	1a	10	Apply Logic "0" to gates to inhibit outputs.
	1b	9	
	1c	7	
	1d	8	
SECOND DECADE	Gate 5	4	
	2a	18	Bit Weight Code a = 8
	2b	17	b = 4
	2c	15	c = 2
	2d	16	d = 1
	Gate 6	13	
THIRD DECADE	3a	24	8-4-2-1 BCD TO DECIMAL CONVERSION
	3b	23	
	3c	21	
	3d	22	
	Gate 7	19	
FOURTH DECADE	4a	30	
	4b	29	
	4c	27	
	4d	28	
	Gate 8	25	
Polarity		1	
Range	b	3	
	a	5	
EXT REF Gate 3		6	
		2	

		DECIMAL NUMBER									
		0	1	2	3	4	5	6	7	8	9
BCD BIT	a	0	0	0	0	0	0	0	0	1	1
	b	0	0	0	0	1	1	1	1	0	0
	c	0	0	1	1	0	0	1	1	0	0
	d	0	1	0	1	0	1	0	1	0	1

DATA	DOU NO. 2 PIN NO.	
FUNCTION:		
VDC	6	Apply Logic "0" to gates to inhibit outputs.
MVDC	8	
VAC	9	
FILTER	11	
Gate 2	2	
Ω	1	Function outputs Logic "1" when true.
KΩ	5	
MΩ	7	
Overload	3	
Gate 1	4	
Overrange "1"	10	
Gate 4	15	
Ready Flag	17	
CONTROL INPUTS:		
Timeouts Enabled	13	Enabled if connected to ground
Ext Trigger	19	
Autotriggering	20	Disabled if connected to ground.
POWER SUPPLY:	29	+5V power for operation of RCU with 500 milli ampere reserve.
+5Vdc	24	
Common	25	
	28	
	30	

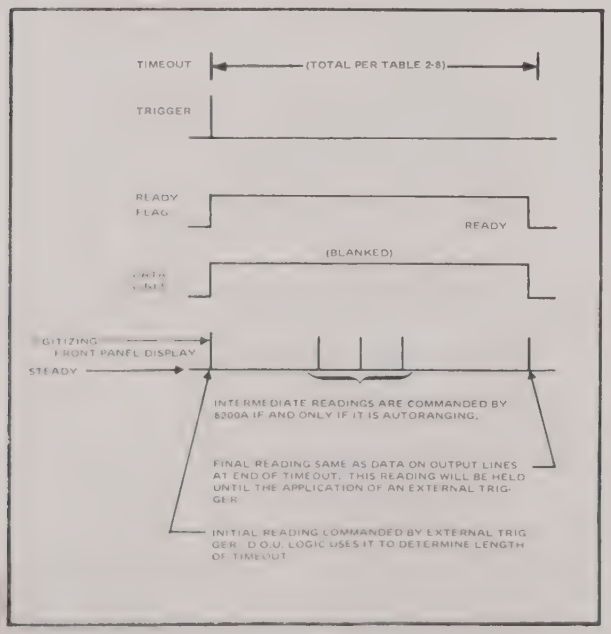

TIMEOUT
(TOTAL PER TABLE 2-8)
TRIGGER
READY FLAG
READY
(BLANKED)
DIGITIZING FRONT PANEL DISPLAY
STEADY
INTERMEDIATE READINGS ARE COMMANDED BY 8200A IF AND ONLY IF IT IS AUTORANGING.
FINAL READING SAME AS DATA ON OUTPUT LINES AT END OF TIMEOUT. THIS READING WILL BE HELD UNTIL THE APPLICATION OF AN EXTERNAL TRIGGER
INITIAL READING COMMANDED BY EXTERNAL TRIGGER. D.O.U. LOGIC USES IT TO DETERMINE LENGTH OF TIMEOUT

Figure 2-9. FRONT PANEL DISPLAY CHANGES DURING TIMEOUT

2-58. AUTOMATIC TIMEOUTS

2-59. The response of the 8200A Data Output Unit to a data request consists of a function-dependent series of delays. When the Timeouts Enabled line is activated, a programmed one-shot circuit in the DOU automatically sequences the dalay series to provide data within specified accuracy in the minimum possible time. If fast settling times are possible for a specific application, the timeouts can be defeated, allowing sample rates as high as 400 per second. Application of +5V logic level or open circuit to pin 13 defeats the timeouts; application of Logic "0" or contact closure to pin 13 enables the timeouts.

2-60. The timing diagram for in-range inputs is shown in Figure 2-10. When programmed timeout operation is selected the programmed one-shot establishes Automatic Delay time T3 to T4. Automatic Timeout delay times are listed in Table 2-10.

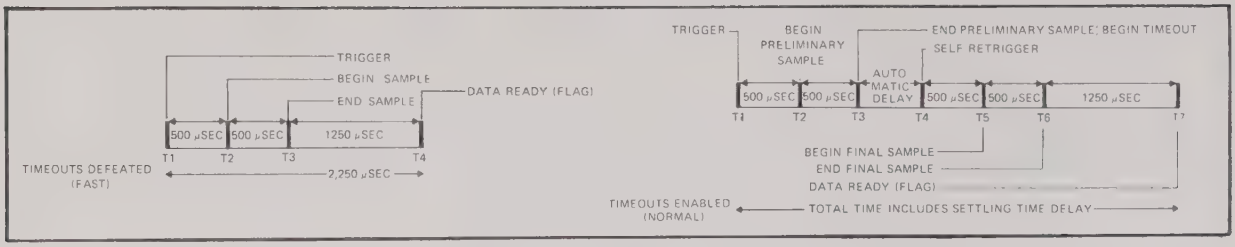


Figure 2-10. DOU TIMING DIAGRAM FOR IN-RANGE DVM INPUTS

Table 2-10. AUTOMATIC TIMEOUT VALUES FOR READY FLAG

FUNCTION/RANGE CALLED	TOTAL TIMEOUT (MEASURED AT READY FLAG OUTPUT)		FUNCTION/RANGE CALLED	TOTAL TIMEOUT (MEASURED AT READY FLAG OUTPUT)	
VDC without Filter 1, 10, 100, 1000	15 msec	±2 msec	KΩ without Filter 1, 10, 100, 1000	17 msec	±2 msec
VDC with Filter 1, 10, 100, 1000	530 msec	±60 msec	KΩ with Filter 1, 10, 100, 1000	1.3 sec	±.15 sec
MVDC without Filter 10, 100	125 msec	±15 msec	10 MΩ without Filter	44 msec	±5 msec
MVDC with Filter 10, 100	2.1 sec	±.25 sec	10 MΩ with Filter	7.4 sec	±.8 sec
VAC 1, 10, 100, 1000	850 msec	±90 msec	RANGE CHANGES – ADD TO TIMEOUTS		
Ω without Filter 100	16 msec	±2 msec	VDC, MVDC, Ω, KΩ, MΩ, without Filter called	25 msec/range change	
Ω with Filter 100	560 msec	±60 msec	All other conditions	255 msec/range change	

2-61. COMPLETELY PARALLEL DATA ACQUISITION

2-62. For completely parallel data acquisition perform, the following steps:

a. Acquire full digits data by connection to decade outputs. Leave inhibit lines associated with each decade open.

b. Acquire function, range, overrange and polarity data as desired. Leave associated inhibit lines open.

c. If data output is to be applied to a printer, the foregoing data could be grouped for presentation in several printer columns, with each column weighted as desired.

d. Acquire Ready Flag for use as desired.

2-63. SERIAL CHARACTER, PARALLEL BIT ACQUISITION.

2-64. For serial character, parallel bit acquisition, perform the following steps:

a. Connect function, range, polarity, and digit outputs in parallel, as shown in Figure 2-11, or in groups of 8, 12, 16 bits, etc., as desired.

b. The user supplied clock controls the inhibit lines to determine the sequence of character acquisition. Data transfer to the output line occurs when the associated inhibit lines are high. Truth tables and acquisition format are shown in Figure2-11.

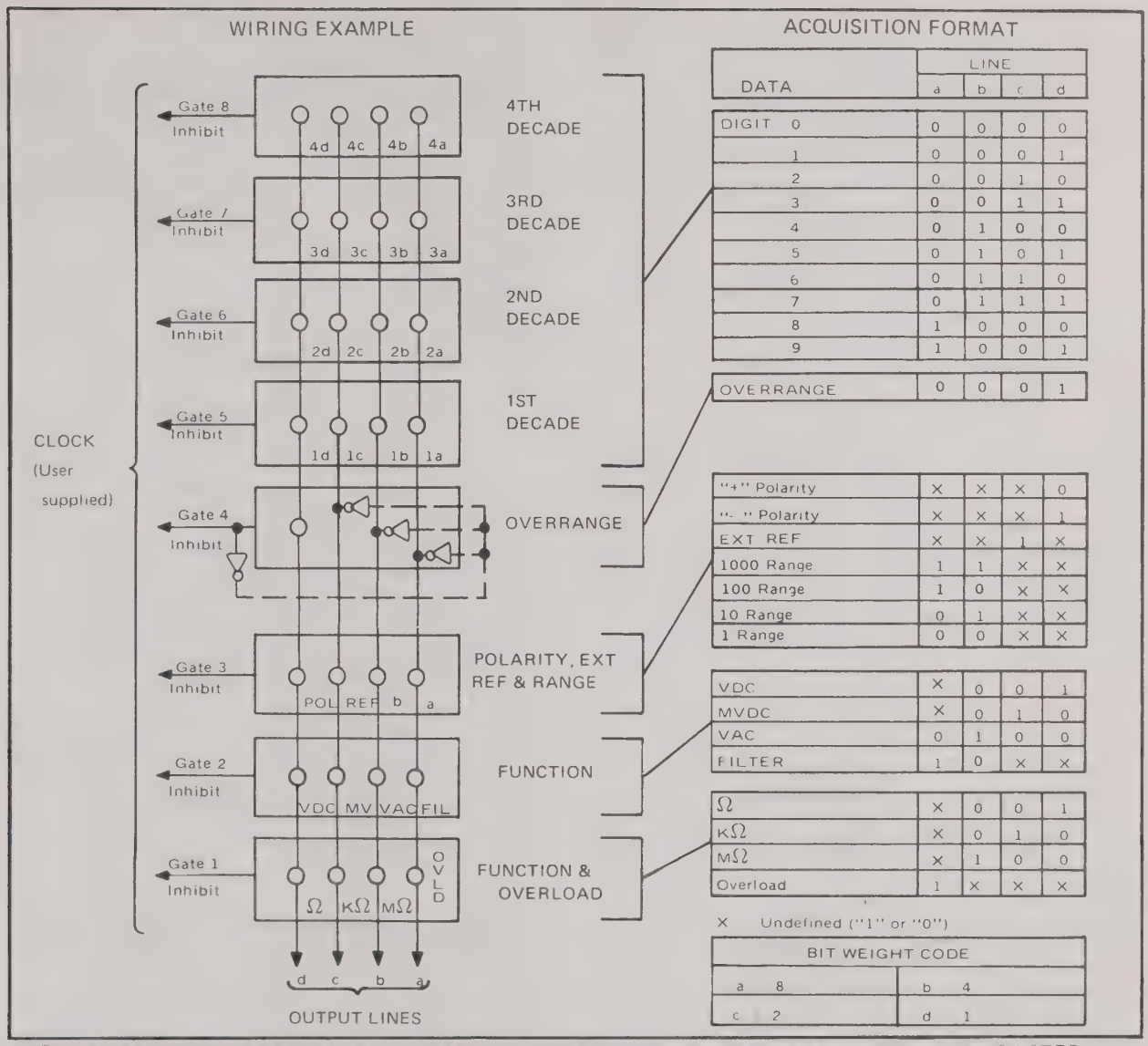

WIRING EXAMPLE
ACQUISITION FORMAT
Gate 8 Inhibit
Gate 7 Inhibit
Gate 6 Inhibit
Gate 5 Inhibit
Gate 4 Inhibit
Gate 3 Inhibit
Gate 2 Inhibit
Gate 1 Inhibit
4d 4c 4b 4a
3d 3c 3b 3a
2d 2c 2b 2a
1d 1c 1b 1a
POL REF b a
VDC MV VAC FIL
Ω KΩ MΩ OVLD
CLOCK (User supplied)
4TH DECADE
3RD DECADE
2ND DECADE
1ST DECADE
OVERRANGE
POLARITY, EXT REF & RANGE
FUNCTION
FUNCTION & OVERLOAD
d c b a
OUTPUT LINES
DATA
LINE a b c d
DIGIT 0 0 0 0 0
1 0 0 0 1
2 0 0 1 0
3 0 0 1 1
4 0 1 0 0
5 0 1 0 1
6 0 1 1 0
7 0 1 1 1
8 1 0 0 0
9 1 0 0 1
OVERRANGE 0 0 0 1
"+" Polarity × × × 0
"-" Polarity × × × 1
EXT REF × × 1 ×
1000 Range 1 1 × ×
100 Range 1 0 × ×
10 Range 0 1 × ×
1 Range 0 0 × ×
VDC × 0 0 1
MVDC × 0 1 0
VAC 0 1 0 0
FILTER 1 0 × ×
Ω × 0 0 1
KΩ × 0 1 0
MΩ × 1 0 0
Overload 1 × × ×
× Undefined ("1" or "0")
BIT WEIGHT CODE
a 8 b 4
c 2 d 1

Figure 2-11. WIRING EXAMPLE, ACQUISITION FORMAT, AND TRUTH TABLES FOR SERIAL CHARACTER, PARALLEL BIT ACQUISITION

2-65. MINIMUM LINES ACQUISITION

2-66. Minimum lines acquisition is a practical application of serial character, parallel bit acquisition, in which a user-supplied clock is placed near the 8200A to sequentially control the inhibit lines. Proceed as follows:

a. Place a customer fabricated 8-segment ring counter near the 8200A and interface it as shown in Figure 2-12.

b. Trigger the 8200A. (The Timeouts Enabled line may be programmed via interface or it may be hard-wired.)

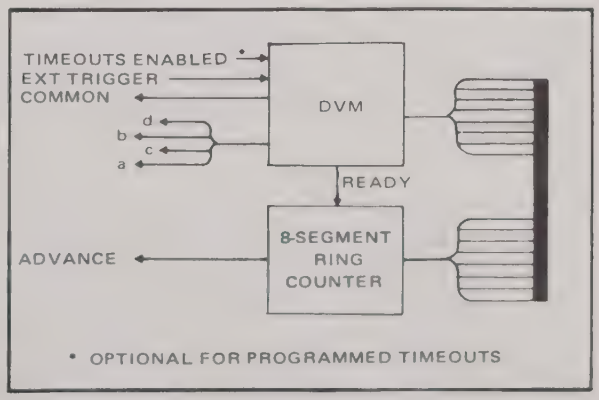


Figure 2-12. MINIMUM LINES ACQUISITION

c. When data is ready, transition of the 8200A READY signal will start the ring counter. A synchronizing pulse, sent from the ring counter's advance line, will allow the acquisition device to recognize the character being acquired on the four output lines.

d. An OVERLOAD line is available to serve as an alarm or priority interrupt.

2-67. Installation instructions for the Data Output Unit are covered in Section 6.

2-68. Remote Control Unit (–08 Option)

2-69. GENERAL

2-70. The A8 Remote Control Unit (RCU) enables the 8200A to be programmed or controlled remotely. RCU inputs are designed to interface directly with DTL/TTL logic. Control by discrete transistors or contact switches is also possible. Operating power for the RCU must be supplied from an external +5 volt source having a current capability of at least 105 milliamperes. Power may be obtained from the Data Output or Printer Output options if the DVM is so equipped.

NOTE!

A +5V power supply is available for the RCU. Contact factory for further information.

2-71. The RCU provides the capability of controlling all DVM functions and ranges, and interlocking logic provided so that incompatible functions or dual ranges cannot be called simultaneously. Acceptable combinations are shown in Table 2-11.

2-72. COMMAND TRIGGERING

2-73. The RCU has two operating modes which control entry of external commands into the unit: continuous command mode and triggered command mode.

2-74. In continuous command mode, the RCU requires no external triggering. It always reflects present state of command inputs. To achieve this mode of operation, hold pins 25 and 27 on the remote control connector open or at Logic "1" (+5V).

2-75. In triggered command mode, the RCU only responds to programming inputs after application of an external trigger. It memorizes input commands within 10 microseconds of trigger application. Following the storage operation, programming inputs may be changed or removed without affecting stored information. To achieve this mode of operation, hold pin 27 (Auto Command Entry Defeat) low by application of Logic "0" or contact closure and apply the external trigger to pin 25 (External Command Entry). Trigger requirements (External Command Entry) are given in Figure 2-13. RCU connector location is shown as item 13 in Figure 2-2. Pin assignments are given in Table 2-12.

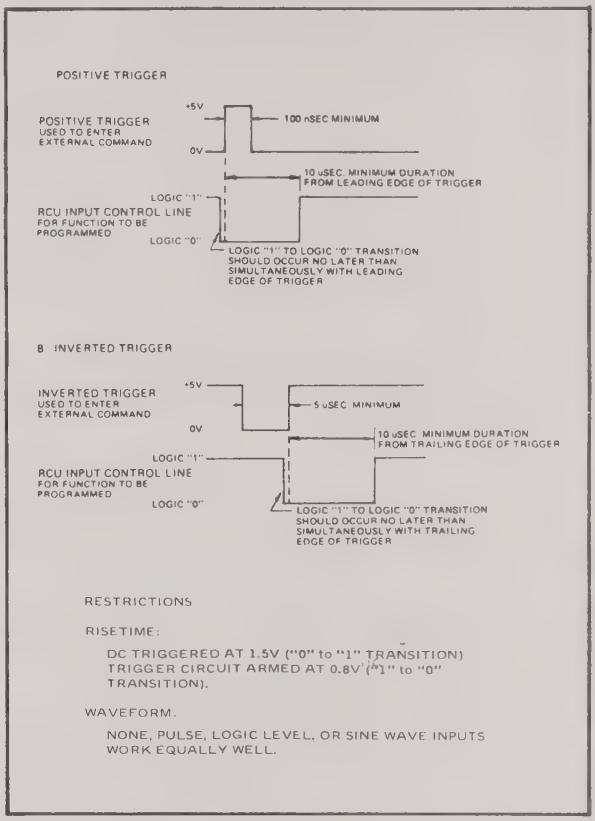

POSITIVE TRIGGER
POSITIVE TRIGGER USED TO ENTER EXTERNAL COMMAND
+5V
0V
100 nSEC MINIMUM
10 uSEC. MINIMUM DURATION FROM LEADING EDGE OF TRIGGER
LOGIC "1"
LOGIC "0"
RCU INPUT CONTROL LINE FOR FUNCTION TO BE PROGRAMMED
LOGIC "1" TO LOGIC "0" TRANSITION SHOULD OCCUR NO LATER THAN SIMULTANEOUSLY WITH LEADING EDGE OF TRIGGER
B INVERTED TRIGGER
INVERTED TRIGGER USED TO ENTER EXTERNAL COMMAND
+5V
0V
5 uSEC MINIMUM
10 uSEC MINIMUM DURATION FROM TRAILING EDGE OF TRIGGER
LOGIC "1"
LOGIC "0"
RCU INPUT CONTROL LINE FOR FUNCTION TO BE PROGRAMMED
LOGIC "1" TO LOGIC "0" TRANSITION SHOULD OCCUR NO LATER THAN SIMULTANEOUSLY WITH TRAILING EDGE OF TRIGGER
RESTRICTIONS
RISETIME:
DC TRIGGERED AT 1.5V ("0" to "1" TRANSITION) TRIGGER CIRCUIT ARMED AT 0.8V ("1" to "0" TRANSITION).
WAVEFORM.
NONE, PULSE, LOGIC LEVEL, OR SINE WAVE INPUTS WORK EQUALLY WELL.

Figure 2-13. TRIGGER REQUIREMENTS

Table 2-11. REMOTE CONTROL UNIT LOGIC INTERLOCKING

FUNCTION	RANGE					FILTER	RATIO
	1	10	100	1000	NONE		
VDC	1	10	100	1000	AUTO	YES	YES
MVDC	100	10	100	10	AUTO	YES	YES
VAC	1	10	100	1000	AUTO	NO	YES
Ω	100	100	100	100	100	YES	YES
KΩ	1	10	100	1000	AUTO	YES	YES
MΩ	10	10	10	10	10	YES	YES
If function and range are not called , DVM goes to VDC mode and autoranges (providing REMOTE button is pressed and power is supplied to the RCU circuitry outside the guard).							
If unavailable range or no range is called , DVM autoranges and autofunctions between MVDC and VDC and between Ω, KΩ and MΩ.							
Remote Flag output is present when REMOTE button is pressed.							

2-76. REMOTE FLAG

2-77. A Remote Flag output is provided at pin 29 of the RCU input connector. This pin is "True" (+5V) when the REMOTE button is pressed.

2-78. OPERATION

2-79. To place DVM in remote operation, proceed as follows: See Figure 2-14 for RCU pin connections.

a. Connect external +5V dc power to pin 4 (+5V) and pin 2 (common).

b. Press FUNCTION REMOTE switch to transfer control of DVM function and range to remote control point.

c. Command a function or range via contact closure or zero volt logic level between appropriate pin and common. For example, to program 10 KΩ, filtered operation, command pins 13, 1 and 26 via contact closure or zero volts to pin 2 (common).

d. Sample rate may be increased from 4 readings per second (basic reading rate) to a maximum of 400 readings per second, with a minimum autorange time of 20 milliseconds per range change, when the DVM is triggered via the Data Output Unit or Printer Output Unit options.

2-80. Installation instructions for the Remote Control Unit are covered in Section 6.

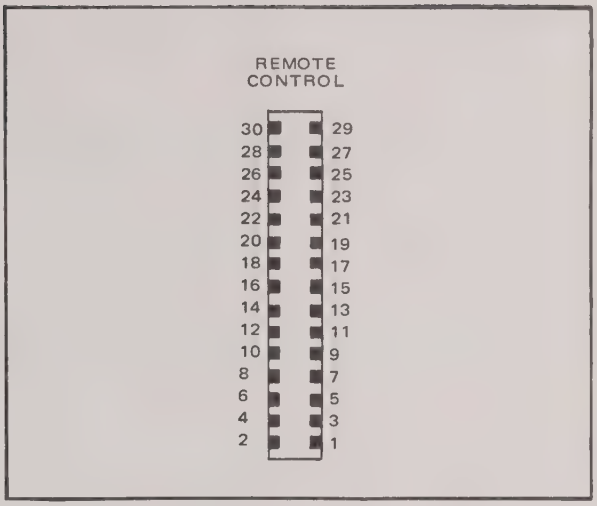


Figure 2-14. RCU REAR PANEL CONNECTOR

Table 2-12. REMOTE CONTROL UNIT PIN ASSIGNMENT

FUNCTION	PIN NO.	FUNCTION	PIN NO.
$\overline{\text{10 Range}}$	1	$\overline{\text{MΩ}}$	15
Common	2	$\overline{\text{MVDC}}$	17
$\overline{\text{1 Range}}$	3	$\overline{\text{VDC}}$	19
+5 Volt Input	4	$\overline{\text{External Reference}}$	21
$\overline{\text{100 Range}}$	5	External Command Entry	25
$\overline{\text{1000 Range}}$	7	$\overline{\text{Filter}}$	26
$\overline{\text{VAC}}$	9	Auto Command Entry Defeat	27
$\overline{\Omega}$	11	Remote Flag	29
$\overline{\text{KΩ}}$	13		

Spare Pins: 6, 8, 10, 12, 14, 16, 18, 20, 22, 23, 24, 28, 30.

NOTE: *1. +5V Input:* *Minimum current requirement = 105 milliamperes.*

2. Logic Levels: *Logic "0" = Contact closure or OV*
Logic "1" = +5V or open.

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section describes the theory of operation of the Model 8200A. The information is arranged under headings of "BLOCK DIAGRAM ANALYSIS" and "CIRCUIT DESCRIPTIONS." Schematic diagrams can be found at the rear of the manual. A block diagram of the Model 8200A can be found in this section.

3-3. BLOCK DIAGRAM ANALYSIS

3-4. Introduction

3-5. The Model 8200A measures dc voltages from 100 μV to ±1200 volts. Four readout tubes, plus an overrange tube, display the measured value. Additional features include autoranging, automatic polarity selection, switched filtering, and options. The options allow ac voltage measurements from 1 mV to 1100V rms, resistance measurements from 10 milliohms to 16 megohms, millivolt measurements from ±1μV to 160mV, dc/dc, mV/dc, and ac/ac ratio measurements, remote control, BCD data output, BCD printer output.

3-6. The following paragraphs describe the basic circuit functions using the block diagram shown in Figure 3-1. First, the operation of the basic instrument involving dc measurement is discussed. Next, the operation of each option is discussed to describe the total instrument capabilities.

3-7. Basic Instrument

3-8. The basic instrument measures and digitally displays dc voltages from 100 μV ±1200V. Basic circuitry consists of an input buffer, A/D analog, logic control, interconnect, display, and a power supply.

3-9. The A4 Input Buffer receives the dc input voltage, attenuates it, and then passes this voltage through a filter and into an inverting amplifier. The input of the Buffer is scaled such that the full-scale output is ±1V. Scaling of the input is done by selection of the pushbutton range switches.

3-10. The A7 A/D Analog receives the output from the Buffer, determines the polarity, and serially digitizes the input voltage. The digitizing process is controlled through commands from the A6 Logic Control assembly. The reference voltage upon which the accuracy and stability are based, is produced in the A/D Analog assembly. The circuitry in the A7 Assembly consists of a polarity detector, sample and hold, A/D amplifier, ladder, current controlled oscillator (CCO), modulator, display storage, and +7V reference. The polarity detector receives the output of the A4 Input Buffer and compares that signal with signal common, thereby sensing the polarity of the Buffer output. This information is then applied to the A12 Display section. At the same time, signals from the digital control in the A6 Logic Control assembly cause the sample and hold circuit to serially digitize the input to the A7 A/D amplifier. This input is derived from the A4 Buffer. The A/D amplifier digitizes the input voltage using a ladder controlled by a counter in the Logic Control assembly. The output of the A/D amplifier is then compared to the reference voltage by a CCO modulator, the output of which controls the CCO in the A6 Logic Control assembly. When the CCO is enabled, it outputs pulses which are counted by the four-bit counter. Pulses continue until the CCO modulator disables the CCO.

The +7V reference supply output is applied to the ladder in the A7 A/D Analog assembly.

3-11. The A6 Logic Control produces the master timing signals from which the measurement periods in the instrument are established. The circuitry consists of a master clock, shift register, current controlled oscillator (CCO), four-bit binary counter, and a sample oscillator. The master clock produces gating signals that synchronize all timing circuitry in the instrument. The shift register is driven by the clock signal and produces digit cycle control signals for the A7 Analog assembly. Any output from the A7 A/D Analog assembly produces an output from the CCO modulator which then causes the CCO to output pulses to the binary counter. The binary counter selects the appropriate steps in the ladder of A7 A/D Analog assembly such that the CCO output is ultimately disabled. The resulting state of the binary counter is also applied to the A12 Display and decoded to indicate the measured value. The sample oscillator sets the sample rate of the instrument. With either the Data Output or Printer Output options installed, the sample oscillator is disabled.

3-12. The A12 Display Assembly decodes and digitally displays the input voltage magnitude and polarity. Digit information is processed in the decoder, which produces the correct display condition in the indicators. The anode scanner receives logic from the shift register in the A6 Logic Control assembly and controls the anodes of the indicators. Selection of FILTER, EXT REF REMOTE, and POWER commands are accomplished via the front panel pushbuttons.

3-13. The A13 Interconnect Assembly provides function and range commands through front panel pushbutton selection. Range commands are received by the range register which controls the range on the A4 Buffer Input assembly and options. The range register also enables the autoranging feature of the Model 8200A.

3-14. The A1 Power Supply Assembly supplies the operating voltages for the instrument. The voltages produced are +200V, ±15V, and +5V. Each voltage is derived from the ac input using a series regulator.

3-15. Options

3-16. Optional features can be installed in the instrument. Each option is shown in Figure 3-1 using dashed-lines. They are described in the following paragraphs.

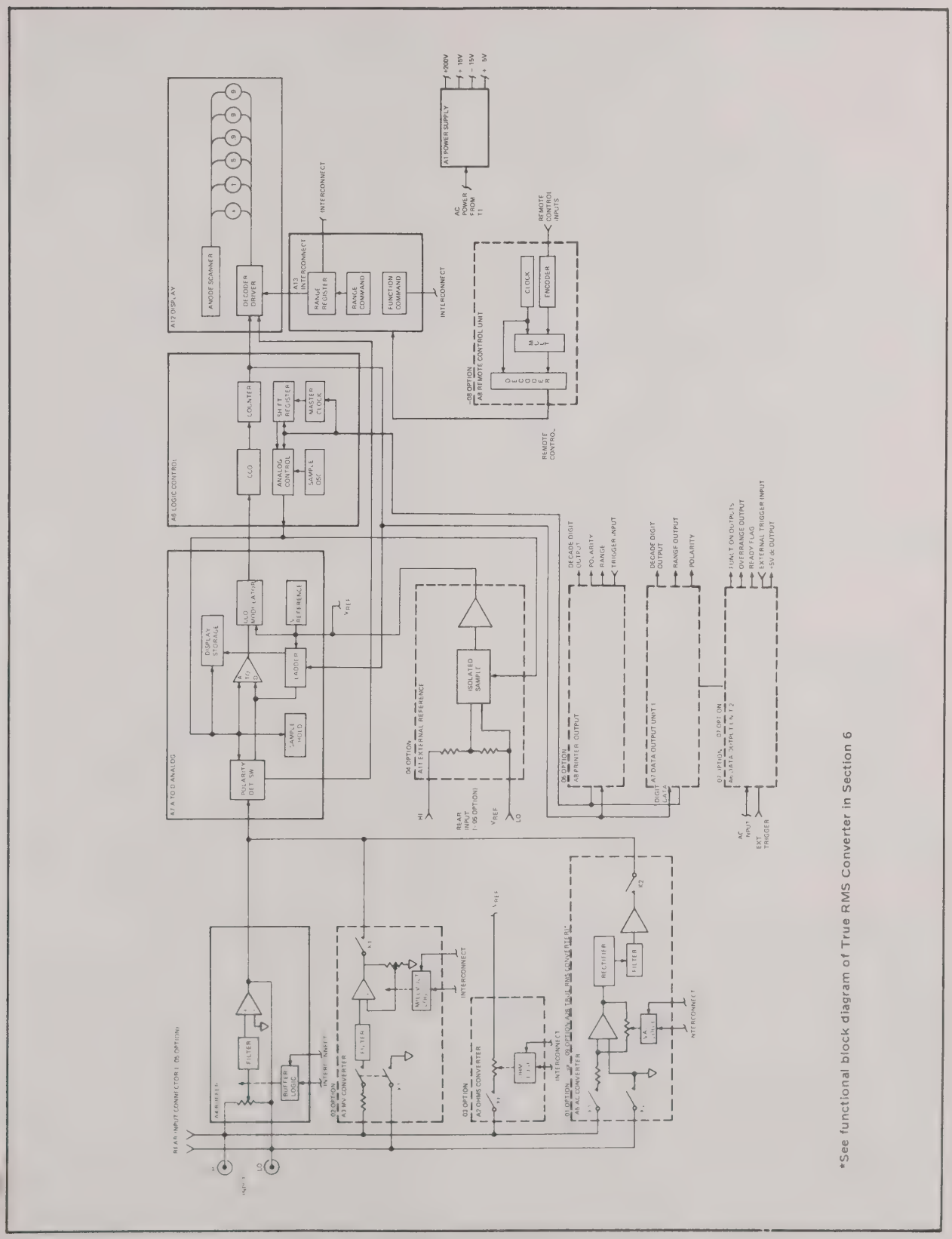
3-17. AC CONVERTER* The A5 AC Converter Assembly is installed as the −01 Option. This circuitry allows ac measurements to 1000V at frequencies from 30 Hz to 100 kHz. The circuitry consists of an operational rectifier, integrator amplifier, and range logic. AC inputs are amplified or attenuated and then rectified in the operational rectifier. The resulting dc voltage is filtered and amplified by the integrator amplifier. Range commands are processed in the range logic whose output establishes a fixed gain or attenuation factor for the operational rectifier. The resulting full-scale +1V dc output is applied to the A7 A/D Analog assembly. This voltage is serially digitized and displayed in the same manner previously described in the basic instrument paragraphs.

3-18. MV CONVERTER. The A3 MV Converter Assembly is installed as the −02 option. This circuitry allows dc measurements from 1μV to ±160 mV dc. The circuitry consists of a filter and an amplifier. The filter network is in effect when the FILTER switch on the front panel is pressed. The amplifier circuitry receives the MV dc input voltage and amplifies the signal by a factor of either 10 or 100 to achieve a full-scale output of ±1V for a full-scale input. When the 100 MV range is selected, the MV Converter is configured as an amplifier having a gain of 10. In the 10 MV range, the A4 Amplifier has a gain of 100. Range and function commands are applied to the logic circuitry for proper conditioning of the amplifier circuitry.

3-19. OHMS CONVERTER. The A2 Ohms Converter Assembly is installed as the −03 option. This circuitry allows resistance measurements from 10 milliohms to 16 megohms. The circuitry consists of a range scaling network and logic controls. When the ohms functions is selected, a range dependent resistance is connected between the reference voltage and the INPUT HI terminal. Since the INPUT HI terminal is virtual ground to the Input Buffer Assembly, a constant current will flow between INPUT HI and INPUT LO terminals. This will produce a voltage across the resistor connected to the HI and LO terminals, which will be monitored by the buffer amplifier.

3-20. EXTERNAL REFERENCE. The A11 External Reference Assembly is installed as the −04 option. This circuitry allows ±dc/dc, ±MV/dc, and ac/dc ratio measurements using an external dc reference voltage. The external reference voltage can be from +1 to +11V dc. Circuitry consists of an input divider, isolated sample circuitry, and a differential amplifier. The external reference input is attenuated by a factor of 0.7 and then applied to the differential amplifier through the isolated sample circuitry for buffering. Application of internal or external reference

* *See Section 6 for theory of True RMS Converter Option.*



*See functional block diagram of True RMS Converter in Section 6

Figure 3-1. MODEL 8200A BLOCK DIAGRAM

voltage to the V_{REF} line is done through front panel selection of EXT REF.

3-21. REAR INPUT. The Rear Input terminals are installed as the −05 option. The three INPUT connectors are connected in parallel with the INPUT terminals on the front panel. Two connections are connected to the External Reference input lines. This option must be installed with the External Reference option (−04).

3-22. PRINTER OUTPUT. The A16 Printer Output Assembly is installed as tne −06 option. This circuitry provides BCD numerical, polarity, and range data lines for printer use. The circuitry consists of a serial encoder, shift register, buffer, external trigger, sample flip-flop, and decade counters. The sample oscillator on the A6 Logic Control assembly is grounded when the A16 Printer Output is installed, thereby allowing the A16 Printer Output assembly to control the sample rate. With no external trigger applied to the A16 Printer Output, the sample flip-flop commands the sample control circuitry at a rate of 4 pulses per second. The sample control buffers these commands and synchronizes the master clock, resets the shift register, and initiates the measure cycle. During the measure cycle the CCO pulses are coupled through the guard to the decade counters. The decade counters also receive commands via the serial encoder and the shift register. The output of both the shift register and decade counters are applied to the buffer circuitry for conditioning prior to presentation as data lines. The external trigger circuitry allows the sample flip-flop circuitry to be controlled by an external trigger. The frequency of the pulses out of the sample flip-flop may be any rate less than 400 pulses per second by application of external trigger pulses. Each external trigger pulse causes the instrument to make one measurement.

3-23. DATA OUTPUT. The A9 and A10 Data Output Unit assembly is the −07 option. This circuitry provides parallel isolated, coded outputs of BCD numerical, polarity, range, and function data. It also provides a +5V dc output for powering option −08 (Remote Control Unit) and/or external equipment as well as input lines for external triggering and control of the measurement cycle. The circuitry is contained on two interconnected printed circuit boards. Numerical and range outputs are available from the Data Output Unit I. Function indications, flag outputs, and +5V dc outputs, in addition to triggering input, are available in the Data Output Unit II.

3-24. REMOTE CONTROL. The A8 Remote Control Unit assembly is installed as the −08 option. This circuitry allows remote control of mode, instrument range, and functions. Input requirements are compatible with DTL or TTL logic levels. The circuitry consists of a clock generator, encoder, multiplexer, and decoder. The clock generator produces an "eight" pulse group for use by the multiplexer. Inputs are coded in the encoder and applied to the multiplexer. The multiplexer output is then serially transferred to the decoder at the clock rate. Serial to parallel conversion takes place in the decoder and the resulting commands are used to control the range and function.

3-25. CIRCUIT DESCRIPTIONS

3-26. The following paragraphs describe in detail the basic instrument circuitry followed by circuit descriptions for the options. Schematic diagrams are located at the rear of the manual. Reference to the appropriate schematic Drawing No. is given at the beginning of each circuit description.

3-27. A4 Buffer

3-28. The A4 Buffer (Drawing No. 8200A-1004) provides a full-scale dc voltage, isolated from the input under measurement, of 1V dc. It consists of five basic elements: input divider, active filter, overload protection, buffer amplifier, and control logic.

3-29. INPUT DIVIDER. The input divider is comprised of R35, R36, R1 through R8, and relay contacts K1 through K5. In the 1 volt range, K1 and K9 are closed and the input divider is bypassed. K2 and K3 are closed in the 10 volt range, thereby making the input divider a 10 to 1 divider. Similarly, K2 and K4 are closed in the 100 volt range for a 100 to 1 divider ratio. K2 and K5 are closed in the 1000 volt range for a 1000 to 1 divider ratio.

3-30. ACTIVE FILTER. The active filter consists of capacitors C1, C3 and through C5, amplifier U1, and relay contacts K6A and K6B. The filter is activated whenever K6A and K6B are closed. This filter provides 60 db rejection at 50 hertz which is increased to 100 db at 200 hertz and above. The values of R35, R36, R9 and R10 are selected so that regardless of the range called, the impedance seen from K6A back through the input to the INPUT LO terminal is roughly 900k.

3-31. OVERLOAD PROTECTION. The overload protection circuitry consists of CR1, CR2, R29 through R34, Q6, and Q7. Overload protection is primarily achieved through the combination of Q6 and Q7. They function as

an active clamp on the input voltage so that U2 and U3 remain in linear operation. This clamp works when the output voltage exceeds ±2 volts. In addition, the unfiltered mode has a clamp comprised of CR25 and CR26 which limits the voltage at that point to less than 0.6 volts. DS1 provides additional protection by limiting the voltage at that point to 100 volts maximum.

3-32. BUFFER AMPLIFIER. The buffer amplifier circuitry consists of dual FET input amplifier U2, operational amplifier U3, diodes CR3 and CR4, transistor Q1, and associated circuitry. One side of dual FET input amplifier U2 receives the input voltage directly (1V range), or receives a scaled down voltage through the input divider. The other side of U2 is returned to signal common through the VDC ZERO adjustment circuit. The output of amplifier U3 is applied to diodes CR3 and CR4, which provide polarity detection information. This signal is then returned through K7B to the INPUT LO terminal; thus, the voltage at the INPUT LO terminal is conditioned so that the voltage on the INPUT HI terminal is at virtual ground. The signal present at the INPUT LO terminal is returned through K8A to the A7 A/D assembly for conversion from analog to digital information. Whenever VDC is not called, the output of the buffer amplifier is attenuated through R15 and R37 and returned to the input of U2.

3-33. BUFFER CONTROL LOGIC. The control logic circuitry consists of NAND gates U4A through U4D, relays K1 through K9, transistors Q2 through Q5, and associated circuitry. The VDC function is commanded by the $\overline{\text{VDC}}$ control line. If the millivolt option is not installed, or if the VDC control line is shorted to ground via VDC pushbutton depressed, Q5 turns on, thereby turning Q4 on which activates K8 and K7 through CR13. Commands of a, b and $\overline{\text{b}}$ provide the range information. If both a and b are low, the outputs of U4 (pins 10, 11, and 4) will all be high. This permits current from the 15V supply to flow to the base of Q3, thus turning on Q8, which in turn activates K1 and K9 in the 1V range. If any of the other ranges are called, the output of U4B, U4C, or U4D will be low, in which case CR9, CR10 and CR11 will pull the base of Q3 low, preventing it from turning on. Current will then flow through the base of Q2 such that Q2 will turn on and activate K2. Simultaneously, K3 K4, or K5 would have been called. When $\overline{\text{VDC}}$ control goes high, Q5 and Q4 are turned off, VDC relay line drops low such that K2, K3, K4, and K5 cannot be turned on. If any of the ohms functions are called (ohms, k ohms, or Meg ohms) K7 and K8 will be activated directly through CR14, CR15, or CR16. Simultaneously, CR17, CR18, or CR19 will turn on Q8 by activating K1 or K9, which provides 1V dc mode for any of the ohms functions. The filter is turned on by the $\overline{\text{FILT}}$ line being returned to ground via FILT pushbutton or a remote control command.

3-34. A7 A-to-D Analog and A6 Logic

3-35. The A7 A-to-D Converter and A6 Logic circuits (Drawings No's. 8200A-1007 and -1006 are discussed together in the following paragraphs since any discussion of the analog-to-digital (A-to-D) conversion process must include elements of both circuits. The basic conversion and logic circuitry involved in the conversion process is shown in Figure 3-2. Also shown is an arbitrary input voltage that is the equivalent to the inverted, unknown voltage applied across the input jacks of the DVM. The output of the converter is shown applied to the following A12 Display stage. This information consists of binary coded data bit groups that are serially emitted from the converter and applied to the display circuits for decoding and serial display. The basic purpose of the combined converter-logic circuitry is to convert the analog voltage input (given as +.6352 dc volts in Figure 3-2) serially by decade to binary coded bit groups; one bit group per decade.

3-36. POLARITY DETECTOR. The polarity detector consists of Q13, Q14, and Q15. The gate input for Q13 (gate 4) is turned on during a subperiod of the measure period. This allows the comparator circuitry (Q14 and Q15) to compare the voltage level on the polarity line with the signal common. If it is positive with respect to signal common, then Q15 will be turned on and consequently $\overline{\text{P}}$ will be high. Conversely, if the polarity line is lower than signal common, then Q14 will be turned on and P will be high. R16 and R20 are used for regenerative feedback to insure that once the polarity decision is made it is not reversed. P being high indicates positive polarity. In this case Q10 and Q16 will be turned on, while Q12 will be off. This permits operation of the A-to-D in the inverting or current mode. If $\overline{\text{P}}$ is high instead, indicating negative polarity, then Q12 will be on while Q10 and Q16 are off. This permits operation of the A-to-D amplifier in the voltage following mode.

3-37. A-to-D AMPLIFIER. The A-to-D Amplifier consists of dual FET U3, operational amplifier U2 and associated circuitry. A20, R29, and C7 constitute the input-over-output network. During zero period, Q20 is turned on and Q16 is turned on, while Q12 and Q10 are off. The output of the A/D Amplifier is applied directly through Q20 to the input of the amplifier (negative input U3). Also, the output of the A/D Amplifier pin 6 is divided by R31 and

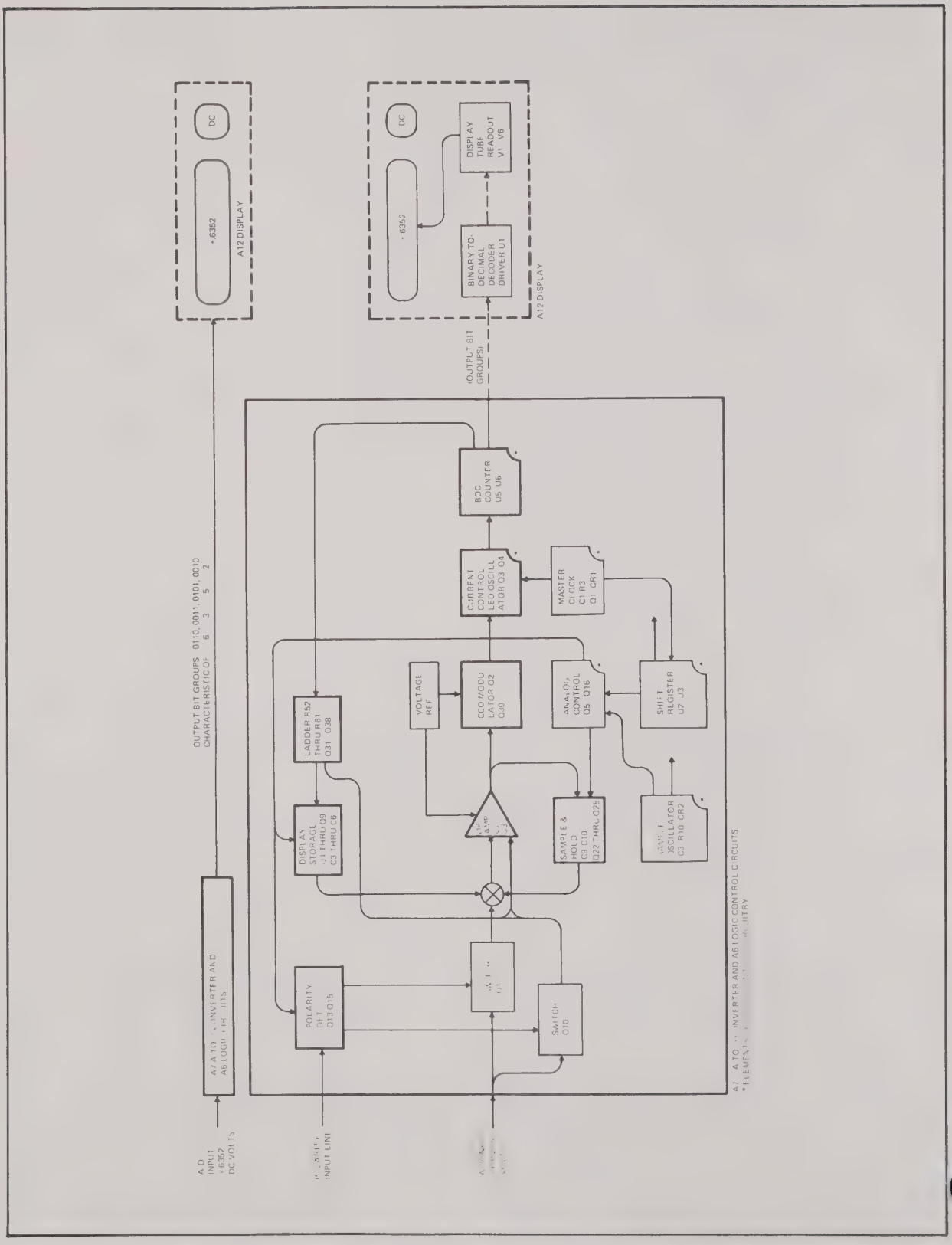

A12 DISPLAY
+6352
DC
A12 DISPLAY
-6352
DC
DISPLAY TUBE READOUT V1 V6
BINARY TO DECIMAL DECODER DRIVER U1
(OUTPUT BIT GROUPS)
OUTPUT BIT GROUPS 0110, 0011, 0101, 0010
CHARACTERISTIC OF 6 3 5 2
BCD COUNTER U5 U6
CURRENT CONTROL LED OSCILLATOR Q3 Q4
MASTER CLOCK C1 R3 Q1 CR1
LADDER R52 THRU R61 Q31 Q38
VOLTAGE REF
CCO MODULATOR Q2 Q30
ANALOG CONTROL Q5 Q16
SHIFT REGISTER U2 J3
DISPLAY STORAGE J1 THRU J9 C3 THRU C6
SAMPLE & HOLD C9 C10 Q22 THRU Q25
OSCILLATOR C3 R10 CR2
POLARITY DET Q13 Q15
SWITCH Q10
A/D INPUT +6352 DC VOLTS
INPUT LINE

Figure 3-2. A-TO-D ANALOG AND LOGIC BLOCK DIAGRAM

the R35, R55, R57, R59, and R61 divider network by division ratio of 70 to one. The divider network output is applied to one side of C7 while the error signal appearing at the output of the amplifier is applied to the other side C7. The voltage stored on C7 is equal to 69/70's of total error signal. When the zero period is completed Q20 is turned off and then C7 acts as a small voltage source in series with the inputs from either Q10 or Q11.

3-38. CCO MODULATOR. The CCO Modulator circuitry consists of transistors Q26 through Q30 and associated circuitry. Q26 in the CCO modulator provides high current capability when more than one digit must be digitized. When high sensitivity is required, differential pair Q27, Q28, and also the pair Q29 and Q30, provide a lower level of current but enough gain to resolve an accurate trip point. R48 is used to adjust this trip point. The output of the CCO modulator commands the CCO on the Logic Control assembly.

3-39. SAMPLE AND HOLD. The sample and hold circuit consists of transistors Q22 through Q25 and capacitors C9 and C10. The sequence of operation for the sample and hold circuit is shown in Figure 3-3.

MEASURE PERIOD SUBPERIODS	ON	VOLTAGES STORED ON SAMPLE AND HOLD CAPACITORS	
		C9	C10
A	Q25	3.52	0
B	Q24, Q23	3.52	5.2
C	Q22, Q25	2.	5.2
D	Q24, Q23	0	2.0
ZERO	Q16, Q20	0	?
1 VOLTAGES SHOWN ARE ONLY PROPORTIONAL TO ACTUAL VOLTAGES.			

Figure 3-3. SAMPLE AND HOLD SWITCHING

3-40. LADDER. The ladder switches of Q31 through Q38 are controlled by drivers Q39 through Q42. The output of the ladder switches is applied to two ladders. Each ladder comprises a 4-bit weighted-resistor, digital-to-analog converter. The primary ladder consists of resistors R52, R53, R55, R57, R59, R61 and produces an output that corresponds to the actual value of the digital input. The secondary ladder, which drives the display storage circuit, consists of resistors R54, R56, R58, R60 and produces an output that approximates the actual value of the digital input. A half-digit bias is produced by R51 in conjunction with the secondary ladder resistors and adds the voltage equivalent of a half-digit to the output of the secondary ladder. This ensures proper display storage readout by compensating for the effects of voltage decay in the storage circuit.

3-41. DISPLAY STORAGE. The display storage circuit consists of FET switches Q4 through Q9 and capacitors C3 through C6. The output of the secondary ladder is supplied to the appropriate storage capacitor through Q4, which is switched on during the second half (display time) of each sub-period. The first (most significant) digit is stored on C3, the second on C4, etc. When the cycle change circuitry switches to storage mode, Q9 is turned on and the analog voltages stored on the storage capacitors are serially applied to the input of the A/D amplifier. Thus, the same reading is continually digitized and displayed until a new sample is taken.

3-42. +7V REFERENCE SUPPLY. The reference supply circuitry consists of reference amplifier U1, transistors Q1, Q2, and Q3 and associated circuitry. Transistor Q1 is a series pass for the 7 volt supply while the reference is obtained through U1 and the voltage divider R8, R7 and R9; R7 being the adjustment for 7 volt supply. The base voltage of U1 must remain fixed relative to the emitter of U1 to insure conduction of Q1. Q3 amplifies the current from U1 while comparing it to the voltage on the base of Q2. The current through Q2 is such that Q1 will always conduct. R75 is short circuit protection of Q1. When the 7 volt disable line is shorted to ground by way of the external reference unit, Q1 is left without any drive so that the internal 7 volt reference supply is disabled.

3-43. MASTER CLOCK. The master clock circuitry produces gating signals that synchronize all timing circuitry in the instrument. The circuitry of the master clock consists of transistor Q1, programmable unijunction CR1, and resistors R1 through R6. The master clock is a programmable unijunction oscillator whose rate is controlled by the time constant of R3 and C1. The charging of C1 through R3 increases the potential on the programmable unijunction until the voltage on the anode of CR1 exceeds the voltage on the gate by approximately 0.6 volts. At that time CR1 acts as a short from anode to cathode, placing the full voltage of C1 on R6. R6 starts to discharge C1, and as soon as the voltage on C1 and R6 is low enough, Q1 will turn on and short out the gate to anode of CR1. This sets CR1 into its off state and restarts the cycle. The resulting output pulse is applied to the clock input of J-K

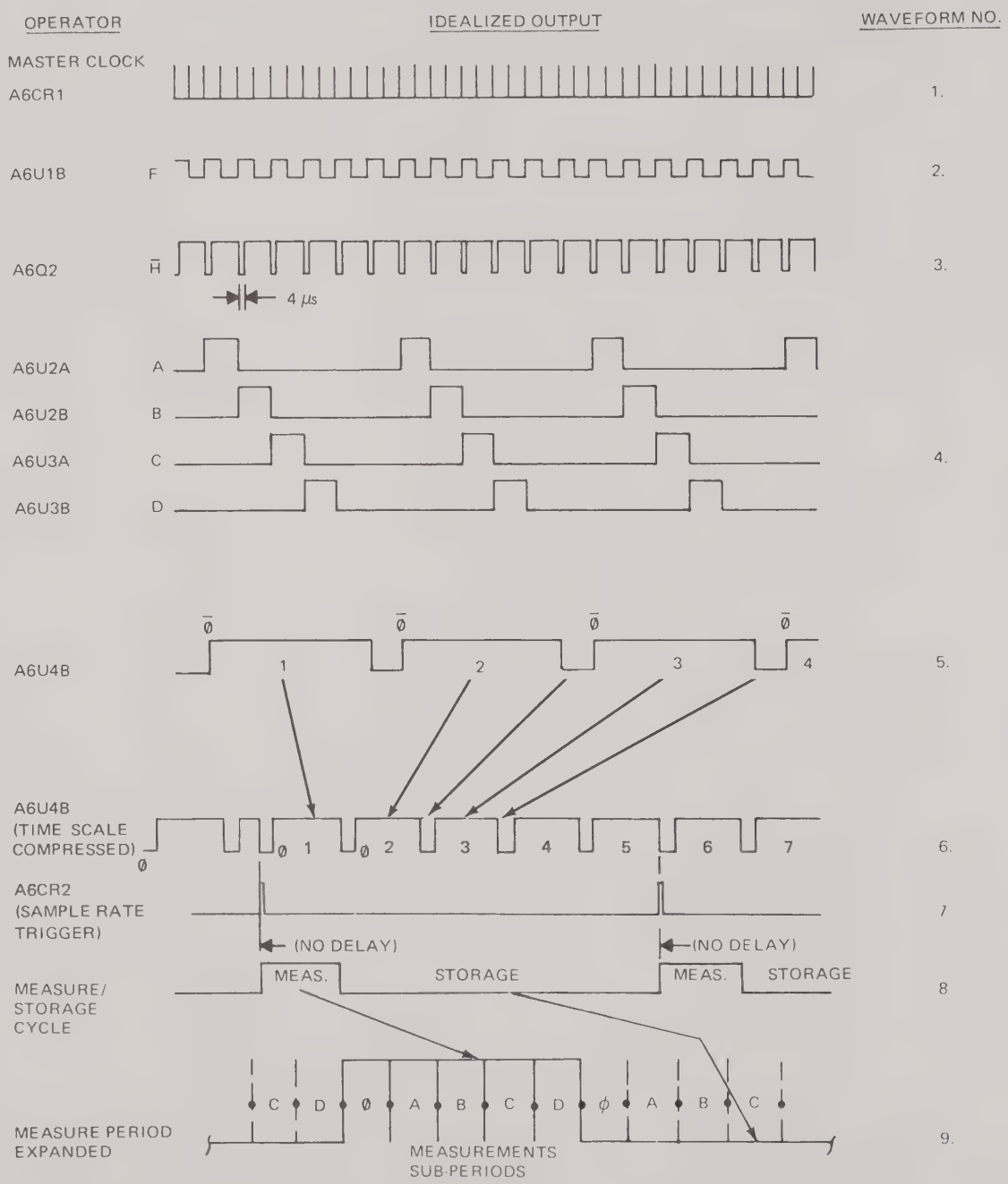


Figure 3-4. DVM TIMING AND SYNCHRONY DIAGRAM (SHEET 1)

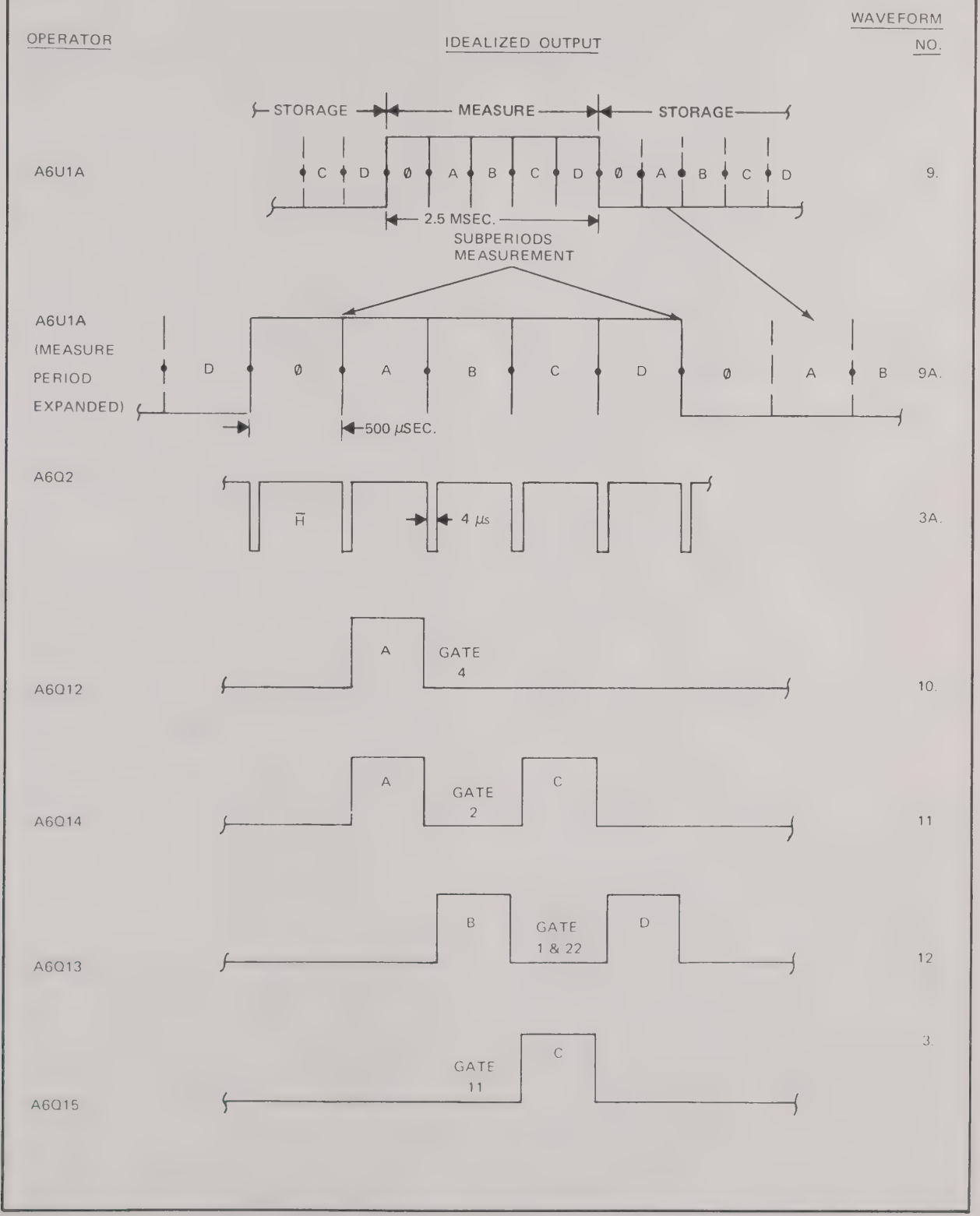


Figure 3-4. DVM TIMING AND SYNCHRONY DIAGRAM (SHEET 2)

flip-flop U1B. On every other pulse the state of F will change causing transistor Q2 to turn on momentarily. The pulse, generated on the collector of Q2, is referred to as $\overline{H}$ which is the separator pulse between periods. $\overline{H}$ pulse is applied to the trigger input of J-K flip-flop U2A, U2B, U3A, and U3B.

3-44. SHIFT REGISTER. The shift register consists of J-K flip-flops U2A, U2B, U3A and U3B. Error correction gate U4B controls the input to flip-flop U2A to ensure proper operation of the shift register. At the end of a typical digitizing cycle, flip-flop U3B reverts to the ZERO condition upon receiving the $\overline{H}$ clock pulse. Since all the flip-flops are now in the ZERO condition, the output of U4B goes low, thereby defining the start of the ZERO sub-period as shown in the timing diagram of Figure 3-4. The ZERO sub-period is terminated by the next $\overline{H}$ clock pulse, which sets flip-flop U2A high because its *J* input was high and its *K* input was low when the clock pulse was received. Subsequent clock pulses set the flip-flop outputs as shown in Figure 3-5.

SUBPERIOD	SHIFT REGISTER FLIP FLOP AND ZERO GATE OUTPUT STATES				
	U2A	U2B	U3A	U3B	U4B
ZERO	0	0	0	0	0
A	1	0	0	0	1
B	0	1	0	0	1
C	0	0	1	0	1
D	0	0	0	1	1

Figure 3-5. SHIFT REGISTER OUTPUTS

3-45. SAMPLE OSCILLATOR. The sample oscillator circuitry sets the sample rate of the instrument. The circuitry consists of unijunction CR2, capacitor C3, and resistors R10 through R13. The frequency of the output is dependent upon the time constant of R10 and C3. When the voltage on the anode of CR2 exceeds the voltage on the gate by approximately 0.6V, CR2 will turn on causing C3 to discharge through R13. CR2 will turn off when the voltage on its gate is low enough, thereby allowing C3 to charge again which restarts the cycle. These pulses are applied to the *J* input of U1A. The output line of U1A is the measurement control line.

3-46. ANALOG CONTROL. The analog cycle control circuit produces the gating and control signals which are used to control the synchronization of events in the analog portion of the DVM, principally in the A-to-D Converter circuits. These signals, together with other control signals, are shown in the DVM Timing and Synchrony Diagram, Figure 3-4. The analog cycle control circuit consists of transistors Q5 through Q16 and associated circuit elements.

3-47. CURRENT CONTROLLED OSCILLATOR (CCO). The CCO consists of multivibrator Q3 and Q4. The CCO has no output until it is supplied current by the CCO modulator and is enabled by the F output of the J-K flip-flop U1B and $\overline{H}$ signal. The CCO output is applied to the clock input of the binary counter. The 9's catcher gate U8A disables the CCO at a count of nine while the DVM is digitizing the second through fourth digits (sub-periods B through D).

3-48. COUNTER. The counter circuitry consists of J-K flip-flop U5A, U5B, U6A and U6B. The counter is a conventional serial type which is reset by $\overline{H}$ between each period. When the count reaches 15, U4A output (pin 6) will go low. This prevents U5A (the input of the counter) from accepting any more pulses and advancing the count. The output (pin 6, U4A) also provides the logic signal for autoranging up; that is when the A period has a count of 15. The nines catcher (U8A) prevents uprange signals during any period except the A period. Similarly, a downrange signal is generated by U8B by detecting the zero state of the counter. The truth table for the flip-flops in the counter is shown in Figure 3-6.

CCO PULSE COUNT	SIXTEEN-STATE BINARY COUNTER			
	U5B Z	U5A Y	U6A X	U6B W
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1
10	0	1	0	1
11	1	1	0	1
12	0	0	1	1
13	1	0	1	1
14	0	1	1	1
15	1	1	1	1

Figure 3-6. BINARY COUNTER OUTPUT

3-49. A12 Display

3-50. The A12 Display circuits (Drawing No. 8200A-1012) processes range, polarity, and digit information for readout display. The circuitry is comprised of an anode

strobing circuit, decoder driver circuit, and polarity memory circuit.

3-51. ANODE STROBING. The anode strobing circuitry strobes the readout tubes, V1 through V6, for proper readout. The circuitry consists of transistors Q1 through Q8 and Q18, and associated circuitry. The A, B, C, and D inputs to respective transistors Q5, Q6, Q7 and Q8 permit the strobing of the readout tubes. In each case the readout tubes will turn on in the second half of these periods. This is achieved through the F signal applied through R6 and CR1 to each of the emitters of Q5, Q6, Q7, and Q8. In the A period when Q5 is turned on, approximately 4V will appear across R1. Q1 will then act as a current regulator, with R5 acting as a limiting resistor. The polarity indicator is keyed for the B period so that when Q6 is on Q18 will also be turned on. R23 then limits the current to the ± indicator. When Q6 is turned on, approximately 4V drop from the 200V supply will appear at the base of Q2 as was the case of the A period on Q1. This permits approximately the same current to flow through Q2 that flowed through Q1. The C and D period behave in exactly the same way as the A period.

3-52. DECODING CIRCUITRY. The decoder driver circuit processes BCD numerical information for application to the readout display tubes. Decoding circuitry consists of U1, transistors Q9 through Q12, and Q17, inverter U2A through U2F, and associated circuitry. Range information is processed through inverters U2B and U2C and transistors Q9 through Q12 for automatic decimal placement. The cathodes of readout tubes V3 through V6 are connected in parallel and to the ten available outputs of the decoder driver. Q17 serves as an overrange (one) indicator driver. Whenever W is high and either X or Y or both are high, Q17 will be turned on to indicate a count of ten or greater. R12 limits the current to V2.

3-53. POLARITY MEMORY. The polarity memory circuitry receives polarity information and conditions V1 for proper display (+ or −). The circuitry consists of transistors Q13, Q14, FET switches Q15, Q16, and associated circuitry. Selection of VDC function on front panel will set the $\overline{\text{VDC}}$ control line low. The P line commands Q15 which will cause the plus display in V1 to illuminate. The $\overline{\text{P}}$ command turns on Q16 which will cause the negative display to illuminate.

3-54. A13 Interconnect

3-55. The A13 Interconnect (Drawing No. 8200A-1013) circuitry consists of function and range command circuitry and a range register. The purpose of the A13 Interconnect assembly is to initiate range and function commands for internal use and provide all interconnections for the various plug-in assemblies.

3-56. FUNCTION COMMAND. The function command circuitry consists of pushbutton switches S1 through S6. The control lines are switched to ground to command the selected function.

3-57. RANGE COMMAND. The range command circuitry consists of pushbutton switches S7 through S11, diodes CR1 through CR12. The set ($\overline{\text{Sa}}$, $\overline{\text{Sb}}$) and reset ($\overline{\text{Ra}}$, $\overline{\text{Rb}}$) range commands are switched to ground through diodes CR5 through CR12 dependent upon the range selected via front panel pushbutton switches. These range commands have direct command over the output of U1A and U1B in the range counter.

3-58. RANGE COUNTER. The range counter is comprised of J-K flip-flops U1A and U1B, NAND gates U3A, B, C, and U4A, B, C, inverters U2A through U2F, and associated elements. U1A and U1B constitute the range code flip-flops. The range register operates in two modes: manual or autorange.

3-59. MANUAL.

3-60. The set (Sa, Sb) and reset (Ra, Rb) commands control J-K flip-flops U1A and U1B, via front panel pushbutton selection, for range commands.

3-61. AUTORANGING.

3-62. Autoranging occurs during the middle of the "A" period. This is achieved by the F signal coupled through C1 and U2A and with "M" and ("A") signals through CR13 and CR14. The autoranging clock is labeled $\overline{\text{Maf}}$. This only comes into play when there are no set or reset commands on U1A and U1B, in which case, the flip-flops are controlled or steered through the *J* and *K* inputs. For the basic instrument, steering is provided through U3C and U4A, for U1B (the a flip-flop) and U4C, U4B, U3A, and U3B for U1A (the b flip-flop). U3C is the significant NAND gate for autoranging up from the 10 range. In that case, b and "UP" will be high which will cause U1B to go high on the next autorange pulse. U4A is the significant NAND gate for autoranging down from the 100 range, in which case $\overline{\text{b}}$ and DN signals are both high which will cause U1B to go low on the next autorange clock pulse. In the 100, or 1000 range, with an up command high, the output of U4C will be low while the output of U3B will be high

and U3A will be high. This will force b to flip-flop high indicating 1000 range on the next autorange pulse. If a downrange command is received instead, the output of U4B will be low and the output of U3B will be low. This will cause b flip-flop to toggle on the next clock pulse so that b can go low if downranging from 1000 range or b can go high if downranging from 100 range. If the a flip-flop, U1B, is low and a uprange command is received, the output of U4C will be low and the output of U3A will be low. This again causes a toggle condition on U1A. This permits b to go high when autoranging from the 1V range or b to go low when autoranging up from the 10 range. If a downrange command is received instead, the output of U4C and U4B will be high and that of U3B will be low. This will force b into the low state on the next clock pulse and allows autoranging down to the 1 range or stopping it at the 1 range.

3-63. A15 Lamp Assembly

3-64. The A15 Lamp Assembly (on Drawing No. 8200A 1013) connects to the A13 Interconnect Assembly (Drawing No. 8200A-1013). The circuitry consists of lamps DS1 through DS6, and resistors R1 through R6. The A15 Lamp Assembly displays the function called by way of relay lines so that the function will not be displayed unless that function is available and can be called.

3-65. A1 Power Supply

3-66. The A1 Power Supply (Drawing No. 8200A-1001) consists of four regulators: two 15 volt regulators, a +200 volt regulator, a +5 volt regulator. The purpose of the power supply is to furnish all required operating power for the instrument.

3-67. The +15 and −15 volts regulators obtain filtered dc voltage from the full-wave rectifiers consisting of diodes CR5 through CR8 and filter capacitors C2 and C4. The +15 volt supply consists of transistors Q3, Q4, Q5 and associated elements. Q3 serves as the series pass for the plus 15 volt supply. Q4 and Q5 control the output of the +15 volt supply. The regulation is achieved by zener diode CR9 and the divider network of R11, R12, and R13. The −15 volt supply consists of transistors Q6, Q7, Q10 and associated elements. R14 and R18 provide a potential at the base of Q7 which must be fixed relative to signal common. This level on the base of Q7 insures conduction of both Q6 and Q10. Q10 is the series pass for the −15V supply.

3-67. The +200 volts regulator is operated from a full-wave bridge rectifier and filter consisting of diodes CR1 through CR4 and capacitor C1. The reference for the +200 volts regulator is the +15 volts. Voltage variations are amplified in transistor Q2 and applied to series pass transistor Q1.

3-68. The +5 volts regulator is operated from a full-wave rectifier consisting of diodes CR13 through CR16 and capacitors C6 through C11. The reference for the +5 volts regulator is −15 volts. The series pass element is Q11. Voltage variations which are detected at the junction of R23 and R24 are amplified by transistors Q13 and Q12.

3-69. Miscellaneous Circuitry

3-70. Input power to the instrument and interconnection to various assemblies is shown in the Wiring and Interconnect Diagrams (Drawing No. 8200A-1000 and 8200A-1100). Line power is fused by F1 and applied through the contacts of POWER switch A12S4 to the primary of a transformer on the A17 Transformer assembly. The primary of T1 consists of two windings which are parallel or series connected through slide switch S1 to allow operation from either a 115 or 230V ac line. When S1 is set to 115, the primary windings of the transformer are connected in parallel. The 230 position of S1 connects the windings in series. Secondary windings of the transformer provide ac voltages to the A1 Power Supply and A10 Data Output Unit No. 2 or A16 Printer Output Unit. Shielding between the primary and secondary windings prevents coupling of any undesired line signals to the internal sections of the instrument.

3-71. A5 AC Converter (−01 Option) *

3-72. The A5 AC Converter consists of two basic parts as shown in Figure 3-7: an operational rectifier and a dc difference amplifier integrator. The operational rectifier consists of an inverting, trans-conductance amplifier and load resistor with negative feedback arranged to provide a loop gain of about 5×10^3 at midband. The feedback is changed with reed switches for range purposes. The input resistor is 1.11 megohms. This value provides 1.11 megohm input impedance at the DVM input jacks. A symmetrical half-wave rectifier placed between the amplifier and load resistor develops equal positive and negative dc voltages proportional to the amplifier output current. At full scale, this current is near two milliamps. The two output waveforms are shown in Figure 3-8.

* *See Section 6 for theory of operation for True RMS converter Option.*

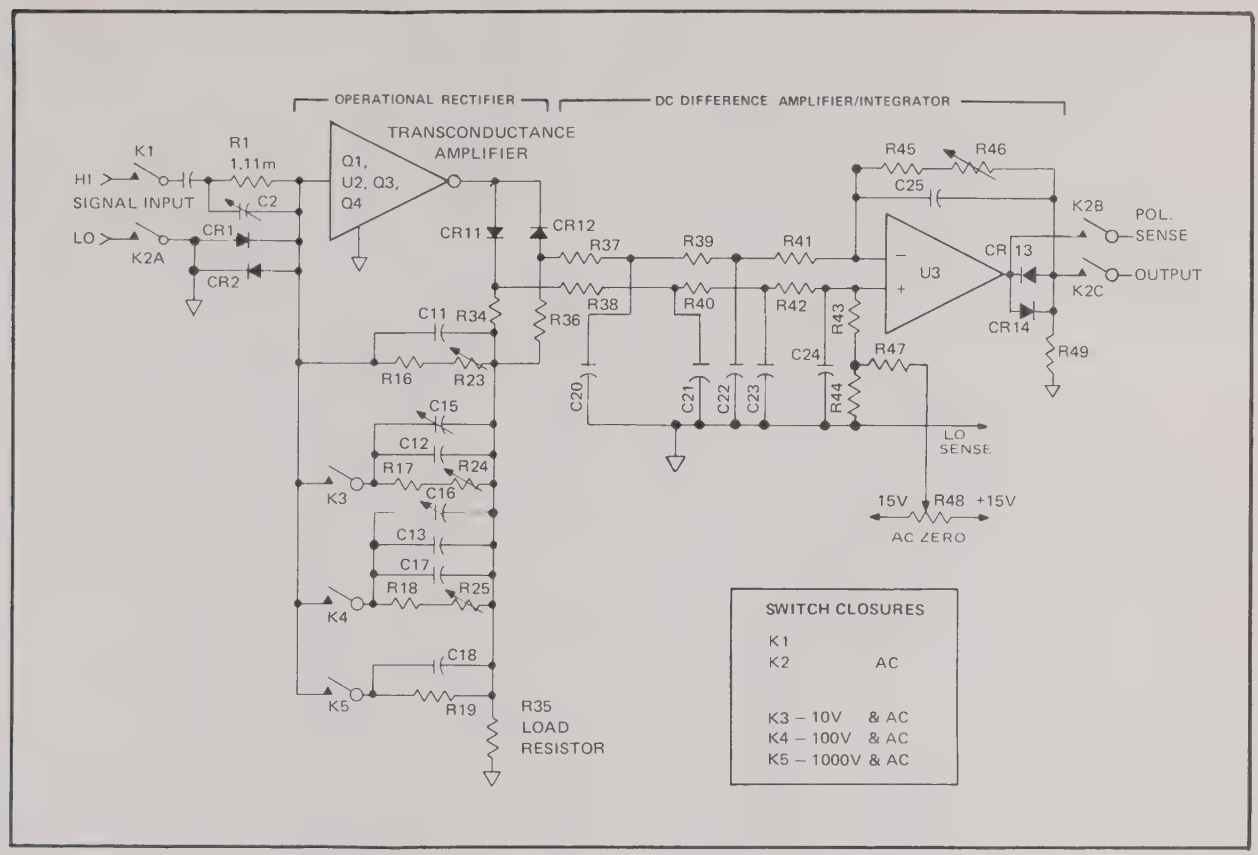


Figure 3-7. AC CONVERTER CIRCUIT DIAGRAM

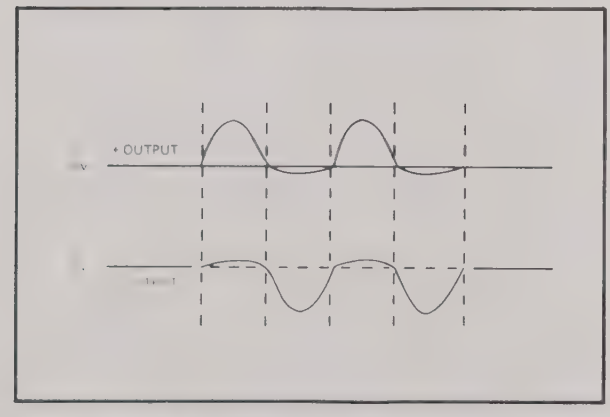


Figure 3-8. RECTIFIER OUTPUT WAVEFORMS

3-73. The dc difference amplifier/integrator filters the outputs (wave forms shown in Figure 3-8) and amplifies the difference between them by a factor of approximately 0.5 for measurement by the A-to-D Converter. Three sections of filtering are provided.

3-74. OPERATIONAL RECTIFIER. Input FET Q1 functions as a source follower, while transistor across FET Q1 provides a low impedance guard voltage which is used to bootstrap most of the capacity that otherwise would appear between the FET gate and circuit common. The first two differential pairs are in dual in-line package U1. Together with Q3 and Q4 they develop the required gain. Transistors Q2 and Q5 function as current sources, with values such that clipping due to overload is symmetrical. Changes in capacitor charges are small and amplifier recovery time is minimized. Transistor Q6 compensates for capacitance losses in the diodes.

3-75. DC–DIFFERENCE AMPLIFIER/INTEGRATOR. The filter network, which provides the input to the amplifier/integrator, consists of resistors R37 through R42 and capacitors C20 through C25. Gain for the dc amplifier is provided by monolithic operational amplifier U3, thereby providing a total loop gain at dc of about 5×10^5.

3-76. RANGE AND FUNCTION CONTROL. The converter input and output relays, K1 and K2, are operated from the $\overline{\text{VAC}}$ control line. The range relays, K3 through K5, are operated by driver circuitry consisting of NAND gates U1A, B, C, and D. These range control gates

accept the outputs of the range register on the A13 Interconnect board.

3-77. A3 Millivolt Converter (−02 Option)

3-78. The A3 Millivolt Converter (Drawing No. 8200A-1003) provides a full-scale dc output voltage, isolated from the input under measurement of 1 VDC. It consists of four basic elements: amplifier, output divider, filter network, and control logic. The input to the A3 Millivolt Converter is derived from the input jacks J22 (HI) and J23 (LO).

3-79. AMPLIFIER. The amplifier circuitry consists of Transistors Q1 through Q6, operational amplifier U5 and U6 and associated elements. The input to the amplifier is through R1 to the contacts of K1, through R3 and R4 to the high input impedance amplifier composed of Q3 and U6. The output of the operational amplifier U6 is applied to transistors Q5 and Q6 for polarity information and to increase current drive. Voltage follower U5 provides a low impedance reference for the bias circuitry. Bias current for the input to transistor Q3 is generated through divider string R5, R6, and R7 and constant current source Q4, R18.

3-80. OUTPUT DIVIDER. The output divider is comprised of resistors R24 through R29 and relay contacts of K3. The output of the amplifier is applied to parallel to the A7 A/D Analog assembly and to the gain determining, output voltage divider. Inspection of the resistance ratios in the output divider shows that the final amplifier output must be 100 times the input in the 10 MV range and 10 times the input in the 100 MV range. Thus, the A3 Millivolt Converter output is the required 1 volt for full-scale inputs.

3-81. FILTER NETWORK. The input filter network is comprised of resistors R1, R3, capacitors C1, C2 and relay contacts K2A, B. The output filter is comprised of capacitor C9, C10 and C11 and relay contacts K2C. This three pole filter provides 80 db rejection of 60 Hz for the 10 MV range and 60 db rejections at 60 Hz for the 100 MV range.

3-82. MILLIVOLT CONTROL LOGIC. This control logic circuitry consists of NAND gates U1A through C, U2A through D, U3A and B, and U4A through D, transistors Q7 through Q10, and associated elements. NAND gates U4A and U4D form a flip-flop arrangement and control selection of MVDC or VDC functions. NAND gates U1A, U2C, U3A, and U3B and transistors Q7 and Q8 control autoranging and logic. NAND gates U3A, U2D, and U4B and transistor Q9 command NAND gates U4A and U4D via $\overline{\text{MVDC}}$ CONTROL, $\overline{\text{VDC}}$ CONTROL, and $\overline{\text{AR}}$ signals. NAND gate U4C controls the activation of relay K3 via range command signal a and $\overline{\text{b}}$. A lockout is provided during the D period so that nonexistant ranges such as 1 MV and 1000 MV are automatically prevented.

3-83. A2 Ohms Converter (−03 Option)

3-84. The A2 Ohms Converter (Drawing No. 8200A-1002) provides a range dependent resistance from the +7V reference to the INPUT HI terminal as shown in Figure 3-9. The A4 Buffer is then operated in conjunction with the A2 Ohms Converter so that the INPUT HI terminal will be held at virtual ground. This forces a fixed current to flow from the +7V reference to the INPUT HI terminal. The circuitry consists of a range scaling network, control logic, and overload protection.

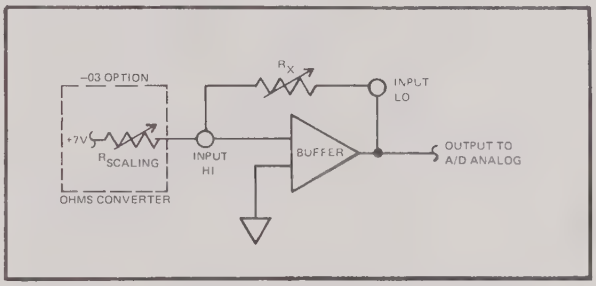


Figure 3-9. SIMPLIFIED DIAGRAM OF OHMS CONVERTER

3-85. RANGE SCALING NETWORK. The range scaling network consists of resistors R1 through R15, R17, R27, relay contacts K1 through K6, and fuse F1. The selection of Ω or KΩ function will cause K6 to close, thereby activating the range scaling network. Table 3-1 shows the status of relays K1 through K6 for all Ω, KΩ and MΩ ranges. Table 3-2 shows the current output for each range. The full-scale voltage across the resistor to be measured is 1V for all ranges.

3-86. OHMS CONTROL LOGIC. The control logic circuitry consists of NAND gates U1A and B, U2A through D, U3A through C, U4A through D, U5A through C, transistors Q1 through Q10, relays K1 through K6, and associated elements. Transistors Q3 through Q5 and Q8 through Q10, plus NAND gates U3A, U3B, U5A command the required function. NAND gates U4A through U4D plus transistors Q6 and Q7 control the range in the KΩ function. NAND gates U1A, U1B, U2A and U2B provide the autoranging gate signals. NAND gate U2D provides a delayed $\overline{\text{MΩ}}$ RELAY line for the autorange logic on the A13 Interconnect assembly. NAND gate U2C provides a delayed Ω RELAY line for logic on the A13 Interconnect assembly.

Table 3-4. OHMS CONVERTER RELAY STATUS

RELAY	RANGE					
	Ω	KΩ				MΩ
	100	1	10	100	1000	10
K1				●	●	
K2				●		
K3		●	●			
K4		●				
K5	●					
K6	●	●	●	●	●	●

NOTE: ● INDICATES CONTACT CLOSURE

Table 3-5. CURRENT OUTPUT, OHMS CONVERTER

RANGE	CURRENT OUTPUT
100Ω	10 MA
1kΩ	1 MA
10kΩ	100 μA
100kΩ	10 μA
1000kΩ	1 μA
10MΩ	100 nA

3-87. OVERLOAD PROTECTION. Protection when the 100Ω range is called is provided by F1, CR1, CR20, CR21, and R14. In all Ω, KΩ or MΩ ranges, the 7V reference supply is protected by CR2, CR20 and CR21.

3-88. All External Reference (–04 Option)

3-89. The All External Reference (Drawing No. 8200A-1011) enables the user to substitute an external voltage for the internal reference of the Model 8200A. The principal use of the Model 8200A when operated in this mode is for voltage ratio measurements: ±dc to dc, and ac to dc. The circuitry consists of an input divider, an isolation circuit, and a buffer amplifier as shown in Figure 3-10.

3-90. INPUT DIVIDER AND PROTECTION CIRCUITS. The input divider produces an output that is 7/10 of the reference input voltage. It consists of resistors R1 through R3. The input divider is adjusted by resistor R2 (10V CAL control). Capacitors C1, C3 and C5, together with the divider resistors form an RC filter which improves the signal to noise ratio. Common mode input protection is provided by CR1 and CR2.

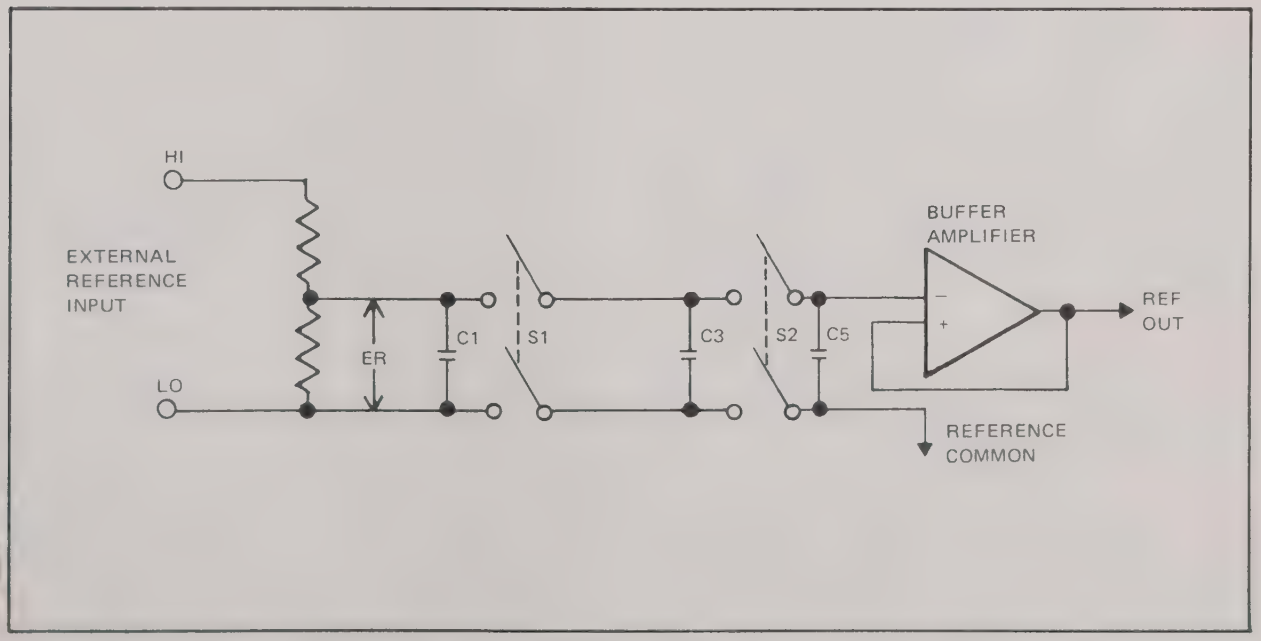


Figure 3-10. EXTERNAL REFERENCE SIMPLIFIED DIAGRAM

3-91. ISOLATION CIRCUIT. The isolation circuit provides a means of isolating the input common of the DC External Reference unit from the output common of the DC External Reference unit. This is necessary to provide 4 terminal ratio capability, and, because the Model 8200A input common terminal (LO) and the instrument common are not equivalent. The LO instrument INPUT terminal is the actual input to the A/D Analog assembly and can have a potential of ±16 volts dc with respect to instrument common. Referring to Figure 3-10, S1 and S2 are arranged so when one is closed the other is open. S1 is closed during a non-critical portion of the measurement cycle (A/D zero time) and capacitor C3 acquires the voltage E_R of C1. When S2 is closed C3 and C5 have the voltage E_R and the output of U1 must be E_R. The switching is achieved by the zero control line, which turns on Q3 during the zero period. When Q3 is on, the voltage on the gates of Q1 and Q2 are minus 15 volts, turning the transistors off. When the gate inputs to U2 are also about −15V, it is turned on. Capacitor C2 delays the turn on of U2 such that Q1 and Q2 are disconnected before U2 turns on. When the zero control line returns to −15V, Q3 is turned off. This allows the voltage on the gates of U2 to rise up to +15V, turning it off. The gates on Q1 and Q2 rise up to a level closely approximating the high and low outputs of U1. C4 is provided to delay the turn on of Q1 and Q2 such that U2 will be turned off before Q1 and Q2 are turned on. This break-before-make feature of Q1 and Q2 and U2 permits the complete isolation of the high and low input terminal.

3-92. BUFFER AMPLIFIER. The buffer amplifier consists of JFET U3, operational amplifier U1, transistor Q4, and associated circuitry. Transistor Q4 and resistor R13 comprise a constant current source for JFET U3. Frequency compensation is provided by capacitors C6, C7, and C8. Capacitor C5 provides a low input impedance for the buffer amplifier during the time switches Q1 and Q2 are off as well as supplying a holding voltage. The reference voltage in the A/D Analog assembly is sensed by a separate line through resistor R17, thereby compensating for line-drops. LOW SENSE (reference common) also originates in the A/D Analog assembly. Diodes CR6 and CR7 provide feedback to JFET U3 input when reed relay K1 is open, thereby maintaining amplifier output within 0.5 volts of the voltage on C3, thus controlling the gate drive for Q1.

3-93. DISABLE CIRCUIT. A low signal (Logic 0) on $\overline{\text{ER}}$ CONTROL line turns on Q5 which pulls the 7V disable line low (Logic 0). This disables the internal reference supply on the A-to-D assembly.

3-94. A16 Printer Output Unit (−06 Option)

3-95. The A16 Printer Output Unit (Drawing No. 8200A 1016) is installed as the −06 option. It provides isolated and buffered data transfer for data logging systems. The circuitry consists of sample flip-flop, sample control, serial encoder, shift register, buffer, counter, decade counters, and a +5V supply. Figure 3-11 is a block diagram of the A16 Printer Output Unit. The external trigger will reset a sample ready indicator which transfers a pulse across the guard to call for a reading. As the reading is being made, the data concerning function, range, and polarity is encoded by a serial encoder. Only four pulses are transferred across the guard to the shift register. This keys the four periods for the decade counters. Upon the completion of the shift register receipt of four pulses, the sample ready state is reset and the buffer is activated for transmitting the data to the data lines.

3-96. SAMPLE FLIP–FLOP. The A16 Printer Output Unit shorts the sample oscillator on the A6 Logic Control assembly to ground and then replaces it with the sample flip-flop circuitry. The circuitry consists of inverters U21D, U21F, and NAND gates U18C and U18D, and associated elements. When both the AUTO TRIG. DISABLE and EX-

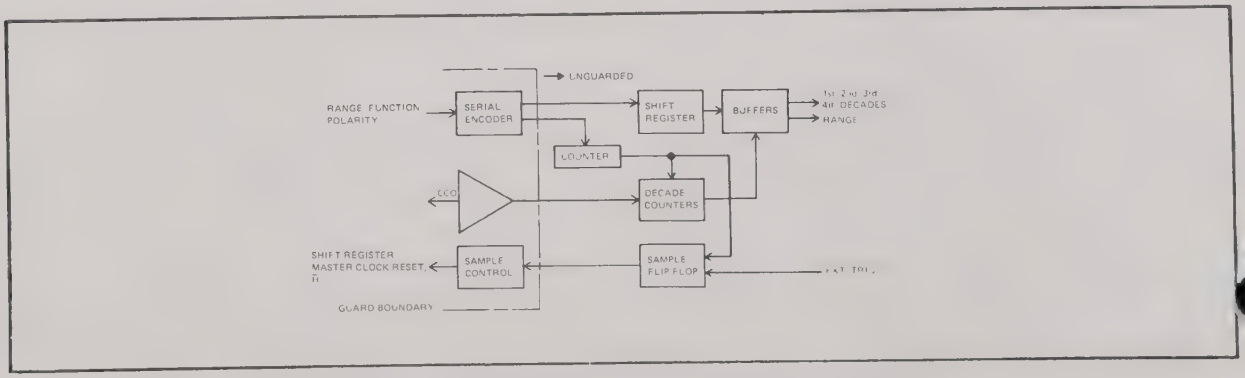


Figure 3-11. PRINTER OUTPUT UNIT BLOCK DIAGRAM

TERNAL TRIGGER lines are high or open (Logic 1) the instrument will automatically trigger four times a second due to the RC time constant of R15 and C8. The output of the sample flip-flop commands the sample control circuitry.

3-97. SAMPLE CONTROL. The sample control circuitry consists of transistor Q1, J-K flip-flop U4B, transformer T3, inverters U1A through U1D, and associated circuitry. When the clock input drops low, Q1 turns on momentarily and causes U4B to toggle. This causes pin 8 to go high and pin 9 to go low. The pulse transition is coupled through C5 to toriad T3 and across the guard where the pulse causes the SHIFT REGISTER RESET, $\overline{H}$, and MASTER CLOCK reset lines to momentarily drop low. This action synchronizes the master clock, initiates the first $\overline{H}$ pulse, and resets the shift register to the zero period, and initiates the measure cycle.

3-98. SERIAL ENCODER. The serial encoder circuitry consists of inverters U1F and U3A through U3F, NAND gates U2A and U2B, toriad T1, inverters U21C and U21E, and associated elements. Polarity, range, and function information is processed through inverters U3B through U3F and then combined in a pulse train for gating NAND gate U2B. NAND gates U2A and U2B are also gated by F and $\overline{\text{zero}}$ lines. NAND gates U2A and U2B pass the commands of function, range, and polarity to the primary of toraid T1. The secondary of T1 imposes its logic onto inverters U21C and U21E; the output of which is applied to the shift register and the counter.

3-99. SHIFT REGISTER. The shift register circuitry consists of NAND gates U18A and U18B plus J-K flip-flops U4A, U17A, and U17B. The shift register is serially loaded by the flip-flop circuitry of U18A and U18B while at the same time being triggered by the negative pulses from inverters U21C and U21E.

3-100. CONTROL COUNTER. The control counter consists of J-K flip-flops U8A and U8B plus NOR gates U7A through U7D. The J-K flip-flops are triggered with a negative pulse. The negative pulses on the clock input of U8A triggers J-K flip-flops U8A and U8B. The J-K flip-flops command NOR gates U7A through U7D, which in turn enable the decade counter. Figure 3-12 shows the triggering sequence of the J-K flip-flops U8A and U8B. The output of NOR gate U7C will be high (Logic 1) prior to J-K flip-flop U8A receiving the first pulse. The remaining NOR gates are selected by the toggling action of the counter.

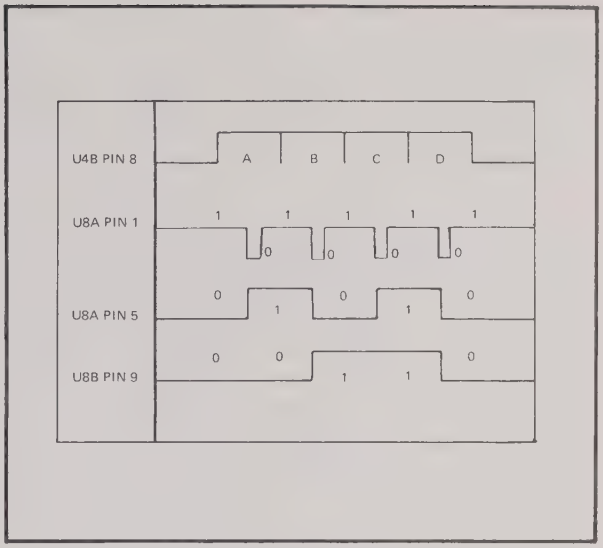


Figure 3-12. PRINTER OUTPUT UNIT TRIGGER SEQUENCE

3-101. DECADE COUNTERS. The decade counter circuitry consists of J-K flip-flops U9A through U16B. The first decade counter is a modified serial type consisting of U15 and U16. U15A, U16A, U15B constitute the first three bits. On the eighth count, pin 9 of U15B will drop low. This sets U16B's output to "eight" high. On the tenth pulse, the output of U15A pin 5 will drop low. This causes the output of U16B pin 8 to drop low and sets the overrange flip-flop consisting of U21B and U21A and C12. After the 15th pulse, the output of U15A (pin 5) and U15B (pin 9) will both be high as will the output at pin 2 of U21A. This causes pin 2 of U6A to go low, which stops the counter so that a sixteenth pulse is not counted. The second decade is a simple four-bit serial counter consisting of U13, U14. The third decade is also a four-bit serial counter consisting of U11 and U12. The fourth decade is also a four-bit serial counter consisting of U9 and U10. The pulses that shift the counters occur in the middle of each period. All pulses are received in the first half of each period so that after 2250 microseconds all the data is complete.

3-102. BUFFERS. The buffer circuitry consists of inverters U5A through F, U6B, C, E, F, U19A through F, U20A through F. This buffer circuitry is used for isolation purposes.

3-103. +5V SUPPLY. The +5 volt supply provides a regulated operating voltage for the A8 Remote Control Assembly (−08 option). The circuitry consists of a bridge rectifier and a series pass regulator. Diodes CR12 through CR15 comprise the bridge rectifier, while transistor Q4

serves as the series pass. Transistors Q2 and Q3 control conduction of Q4. Regulation is determined by the divider string R18, R19 and CR16.

3-104. A9 and A10 Data Output Unit 1 and 2 (–07 Option).

3-105. A9 Data Output Unit No. 1 and A10 Data Output Unit No. 2 (Drawings No. 8200A-1009 and 8200A-1010) are discussed together in the following paragraphs since any discussion of the data output capabilities must include elements of both circuits. The circuitry is shown in Figure 3-13. The DOU option provides a complete status, digitally coded in unguarded circuit form. Data is transferred across the guard every time there is a reading made by the A-to-D circuit of the instrument. These readings can be commanded by an external trigger or incur automatically whenever a range change is made. In the case of an external trigger, the ready indicator transitions to Logic "1" and a sample command is generated. The sample command is transferred across the guard where the sample control circuitry synchronizes the master clock and shift register for a reading. As this reading is being taken, function, range, and polarity data is being encoded by the serial encoder and is transferred across the guard synchronized with the CCO pulses. The shift register advances its state upon receiving pulses and enables the various decade counters at appropriate times. When all the pulses have been transferred across the guard (there are eight) the ready indicator goes to Logic "0" and the buffer gates are allowed to transfer the data to the data lines. If automatic delays are desired, the program one shot is activated at the time of the trigger input along with the ready indicator being disabled and an initial sample command being made. When this data is transferred back into the shift register, the ready indicator is not reset and thus this data is not available to the data lines. However, when the program one shot completes its time out, the sample command is reactivated and the sample control calls for another reading. While this reading is being taken, data transferred across the guard is allowed to reset the ready indicator and activate the buffer gate so that data can again be transferred to the data lines. Whenever a range change is made, the range change detector transfers a pulse across the guard which activates the range change delay. At the completion of the range change delay, the sample command and program one shot are activated. If automatic time-outs are desired, the operation then proceeds exactly as previously described. An additional feature of the DOU option is the gate control lines which permit the multiplexing of data on the data lines.

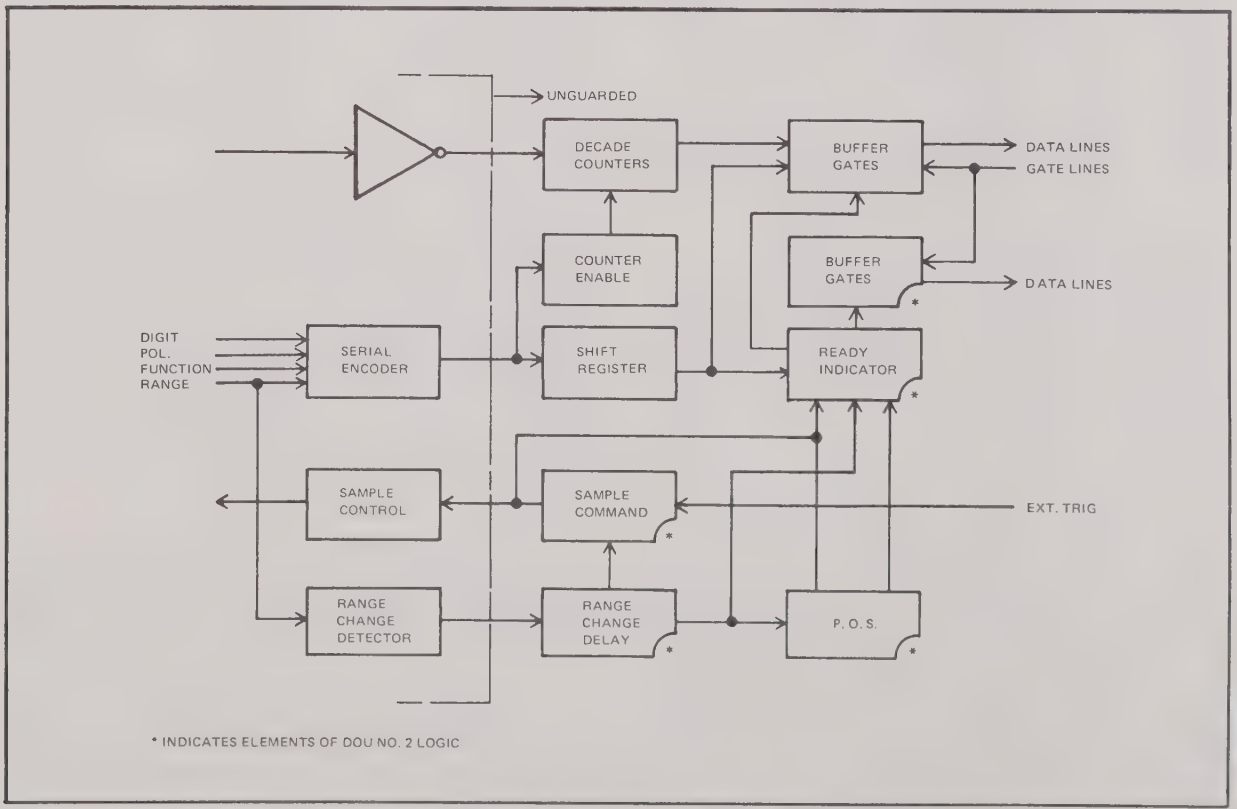


Figure 3-13. DATA OUTPUT UNIT NO. 1 AND NO. 2 BLOCK DIAGRAM

3-106. SAMPLE COMMAND. The DOU Unit No. 1 shorts the sample oscillator on the A6 Logic Control assembly to ground and replace it with the sample command circuitry located on DOU No. 2. The circuitry consists of NAND gates U8A through U8D, RC network R38, C14 and associated elements. When both the AUTO TRIGGERING and EXTERNAL TRIGGER lines are high (Logic 1) the instrument will automatically trigger four times a second due to the RC time constant of R38 and C14. This action sets the sample rate of the instrument. By use of an external trigger, the sample can be programmed for up to 400 readings a second. The output of the sample command circuitry is applied to the sample control circuitry.

3-107. SAMPLE CONTROL. The sample control circuitry consists of J-K flip-flop A10U2B, transformer A9T4, inverters A9U5D and E, transistor A9Q4, and associated circuitry. The trigger signal from the sample command circuitry is applied to the clock input of J-K flip-flop A10U2B. The *J* input of U2B is connected to the ready line (collector of Q7). This line is high when there is no measurement being processed and the data is ready. With the trigger applied to the trigger input of U2B when the *J* input is high, the output pin 9 will go high and pin 10 will go low. This will cause Q7 to turn on indicating a not ready status. Pin 10 of U2B is capacity coupled through C6 to T4 of DOU 1 board. Toriad T4 transfers the pulse across the guard, where it turns on Q4 and also causes the output of U5D and U5E to go to a low state. This causes a master clock to be synchronized and the first $\overline{H}$ pulse initiated as well as resetting the shift registers, zero period initiated, and the measure cycle started on the A6 Logic Control board. During the measurement cycle, pulses from the CCO are transmitted by U5F through T3 to the unguarded section.

3-108. SERIAL ENCODER. The serial encoder circuitry consists of NAND gates A9U1A through C, A9U2A through C, A9U3A, A9U3B, NOR gates A9U4A through D, inverters A9U5A through C, NAND gates A9U6A and B, Toriad A9T1, and associated elements. Simultaneous with the measurement cycle, data is encoded and transmitted across the guard through T1. Two pulses are sent across for each period; one at the beginning and one in the middle of the A, B, C, and D periods. Figure 3-14 shows what information is carried by these pulses. The pulses in Figure 3-14 are achieved via commands into NAND gates A9U1A through C, and A9U3A and B plus NOR gates A9U4B, C, and D. NOR gate A9U4A is connected as an inverter whose output commands NAND gate A9U6B. The pulse train also commands NAND gate A9U6A. F and $\overline{F}$ commands are applied through inverters A9U5A, B, and C to gates of NAND gates A9U6A and B. These commands provide pulses at the start and middle of the measurement periods. ZERO command is applied to NAND gates A9U6A and B to eliminate any pulse output in the zero period. Transformer T1 passed the pulse train across the guard. For positive sense pulses current will be through CR15 and R23. Q5 will then be turned on momentarily providing Q7 is not on. For a negative sense pulse current is conducted through CR14 and R24. Q6 is then turned on momentarily provided Q8 is not on. Q7 and Q8 are off whenever output U2B on DOU 2 board pin 10 is low which is the not ready condition.

3-109. RANGE CHANGE DETECTOR. The range change detector circuitry consists of transistors Q1, Q2, Q3, Toriad T2, and associated elements. The $\overline{b}$ range code commands transistor Q1 while the A range code commands transistor Q2. The output of both Q1 and Q2 command transistor Q3 which drives transformer T2. The secondary of T2 is applied through A10C19 to the set line of A10U2A and A10U1C.

3-110. RANGE CHANGE DELAY. The range change delay circuitry consists of NAND gate A10U3B, inverter A10U1C, transistors A10Q13 through Q16, and associated elements. NAND gate A10U3B and inverter A10U1C form the range delay flip-flop. The output of this flip-flop is applied to the set line of J-K flip-flop U2B. While the output of NAND gate A10U3B is low, current will be conducted through CR33 so that A10Q3 will be on. This prevents the program one-shot time delay time out from occurring until after the range change delay is completed. During the range delay time out, current will be conducted to A10Q7, which turns it on, thereby commanding a not ready status.

3-111. PROGRAMMED ONE-SHOT. The programmed one-shot circuitry consists of J-K flip-flop A10U2A and B, transistors A10Q3 through Q6, NAND gates A10U3A and C and A10U4A through D, plus associated elements. A trigger from the sample command circuitry is applied to J-K flip-flops A10U2A and B. This results in a reading being called through J-K flip-flop A10U2B. Simultaneously the output of J-K flip-flop A10U2A commands transistor A10Q3 off, allowing capacitors A10C1 and A10C2 to discharge through resistor network A10R10 through A10R20 depending upon function called. This rc network determines the length of timeout. A10C1 and A10C2 discharge to a valve that enables A10Q4 to turn on which commands A10Q5 on, which in turn resets A10U2A to its stable state. In the stable condition A10U2A will command transistor A10Q3 on allowing A10C1 and A10C2

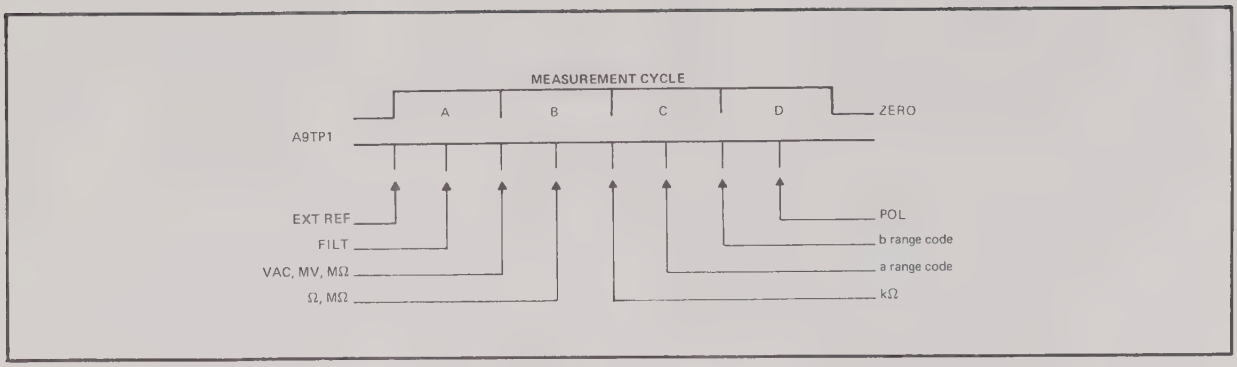


Figure 3-14. DOU I, SERIAL ENCODER INFORMATION

to recharge. The programmed one-shot is disabled when the POS line is commanded high (Logic "1").

3-112. SHIFT REGISTER. The shift register circuitry consists of J-K flip-flops A9U7A and B, A9U8A and B, A9U9A and B, and A9U10A and B. Positive output pulses from the serial encoder A9Q5 are applied to the set line of J-K flip-flop A9U7A. Negative pulses from the serial encoder A9Q6 are applied to the reset line of A9U7A. Diodes A9CR11 and A9CR13 provide a pulse in either condition for advancing the state of the shift register.

3-113. CONTROL COUNTER. The control counter consists of J-K flip-flops A9U15A, A9U16A, A9U16B, NOR gates A9U17A through D. The pulse train that loads the shift register also pulses the control counter. Figure 3-15 shows output sequence of NOR gates A9U17A through D which are commanded by J-K flip-flops A9U15A, A9U16A and B. The output of NOR gates A9U17A through D select the appropriate decade counter to be loaded. A9U17A through D select the appropriate decade counter to be loaded.

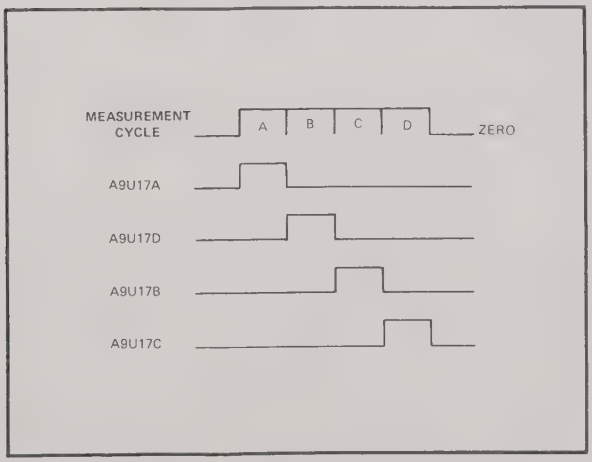


Figure 3-15. COUNTER SEQUENCE

3-114. DECADE COUNTER. The decade counter circuitry consists of J-K flip-flops A9U11A and B through A9U14A and B and A9U21A and B, and associated elements. CCO pulses transferred across the guard by transformer A9T3 load the decade counter. On receipt of the eighth pulse, the output of A10U20B pin 9 goes low, setting the output of U21B pin 8 high. The tenth pulse cause the output of A9U20A to go low. Applied to the trigger input of U21B forces the output low. This in turn causes the output of A9U15B (overrange bit) to go high. When the count reaches 15 (that is, when pin 5 of A9U20A and pin 9 of A9U20B and 9 of A9U15B are all high) the output of A10U5C goes low. This pulls the *J* and *K* inputs A9U20A low through A9CR28, thus preventing a count of higher than 15. If a sixteenth pulse or more should occur after A10U5C is low, A9U5A will also go low. This sets the overload flip-flop comprised of A10U1D and E. The second decade counter comprised of A9U18 and A9U19 is a four-bit serial counter, as is the third decade counter comprised of A9U13, A9U14, and the fourth decade counter A9U11 and A9U12. At the start of every reading when pin 9 of A10U2B goes high, A10Q8 is turned on momentarily by A10R29 and A10C13. The voltage on the collector of A10Q8 is used to reset the overload flip-flop through A10CR23 and all the counters on the DOU 1 board.

3-115. BUFFER GATES. The buffer gates circuitry consists of NAND gates on both the A9 Data Output Unit No. 1 and A10 Data Output Unit No. 2. These NAND gates are A9U22A, B, C, D through A9U26A, B, C, D, and A10U6A through D, A10U7A through D, and A10U5B. The buffer gate circuitry makes available all digit, function, range or overrange information. Additional external gating is provided through CR18, CR20, CR22, CR26 on the DOU 1 board CR26 and CR28 and input pin 9 of U5B on DOU 2 board. This permits output line busing.

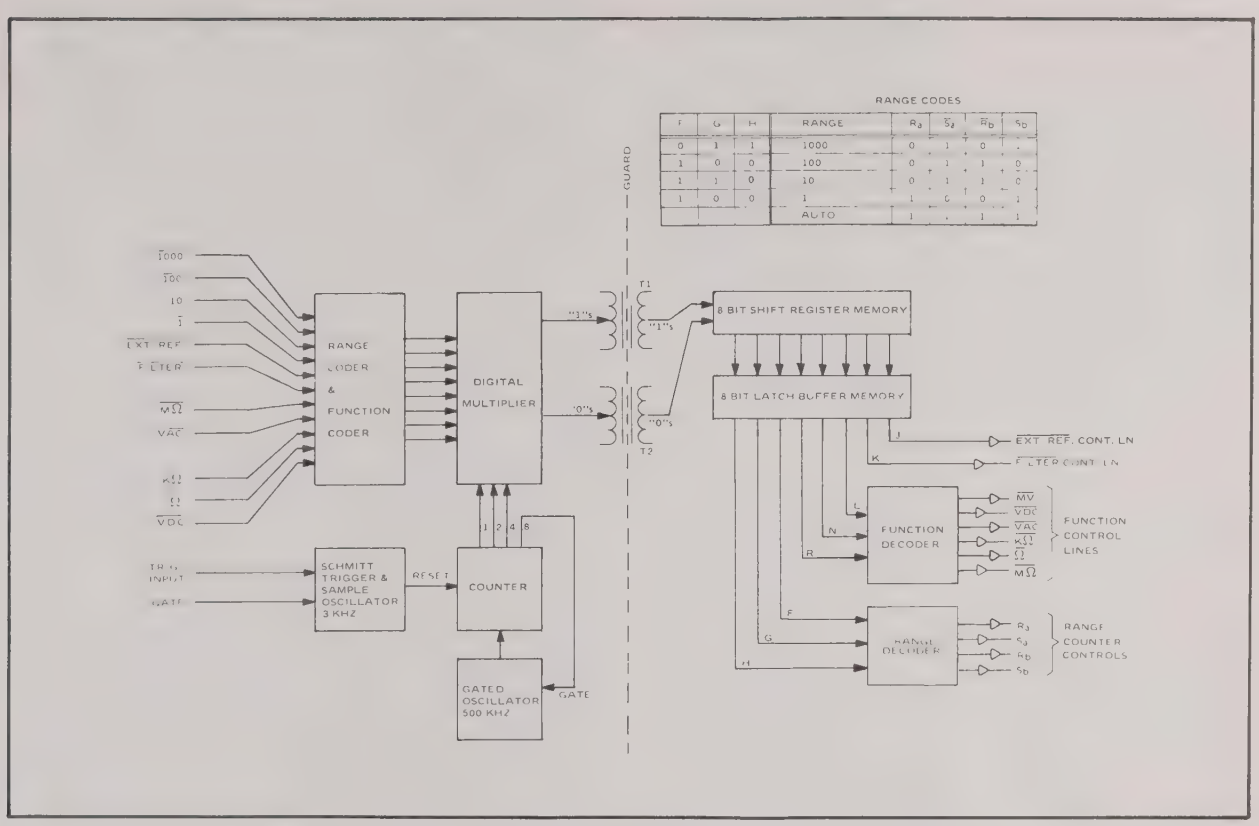


Figure 3-16. 8200A REMOTE CONTROL UNIT BLOCK DIAGRAM

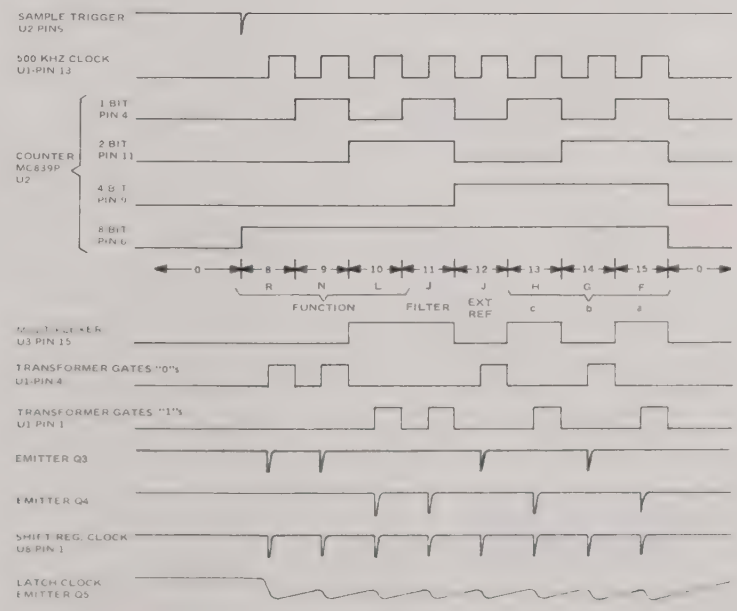


Figure 3-17. REMOTE CONTROL SAMPLE LOAD SEQUENCE

3-116. A8 Remote Control Unit (–08 Option)

3-117. The A8 Remote Control Assembly (Drawing No. 8200A-1008) is installed as the –08 Option. A functional block diagram is given in Figure 3-6. The sample load sequence in given in Figure 3-17. The input function and range commands are applied to coders and then delivered to a multiplexer. The multiplexer receives sequential address information from a counter and, combined with the range and function codes, applies control information to two isolation pulse transformers. The serial output of these two pulse transformers is applied to the shift register for conversion back to 8 time slots which are then buffered and decoded and presented for use.

3-118. FUNCTION AND RANGE CODERS. The purpose of the function and range coders is to compress the 12 input lines into 8 channels with function/range interlocking. The interlocking feature prevents incorrect function and range combinations. Gates U5A, U5B, U5C, U6A, U6B, U6C, present encoded range and function information to the digital multiplexer. Table 3-3 shows Function codes and Table 3-4 shows Range codes.

Table 3-3. FUNCTION CODES

$\overline{VDC}$	$\overline{VAC}$	$\overline{MVDC}$	Ω	kΩ	MΩ		N	R	L
1	1	1	1	1	1	VDC	0	0	0
0	1	1	1	1	1	VDC	1	0	1
1	0	1	1	1	1	VAC	1	1	0
1	1	0	1	1	1	MVDC	0	0	1
1	1	1	0	1	1	Ω	0	1	0
1	1	1	1	0	1	kΩ	0	1	1
1	1	1	1	1	0	MΩ	1	0	0

Table 3-4. RANGE CODES

INPUTS					OUTPUTS				INTERNAL CODE		
$\overline{1.0}$	$\overline{10}$	$\overline{100}$	$\overline{1000}$	COMMAND	$\overline{S_a}$	$\overline{S_b}$	$\overline{R_a}$	$\overline{R_b}$	H	G	F
1	1	1	1	AUTO	1	1	1	1	0	0	0
0	1	1	1	1	0	0	0	0	0	0	1
1	0	1	1	10	1	0	0	1	0	1	1
1	1	0	1	100	0	1	1	0	1	0	1
1	1	1	0	1000	0	0	1	1	1	1	1

3-119. COUNTER AND GATED OSCILLATOR. The purpose of the counter and gated oscillator circuitry is to supply sequential address information to the multiplexer in response to a start pulse from the Schmitt Trigger and Sample Oscillator Circuitry. The start pulse resets the counter to binary 8 (1000). The counter U2 then releases the gated oscillator and allows it to oscillate at 500 kHz. Gates U1C and U1D, capacitors C1, C2 and resistors R1, R2 are the gated 500 kHz oscillator circuitry. The output of the gated oscillator is applied to the counter U2. When enabled, the oscillator causes the counter to cycle through eight states. (Refer to Table 3-5). As soon as state "0" (i.e. 000) is reached by the counter, the oscillator is disabled by the counter, which in turn stops the counter from further counting. This sequence will not start again until a start pulse is received by the counter from the Schmitt Trigger circuitry.

3-120. SCHMITT TRIGGER AND SAMPLE OSCILLATOR. The purpose of the Schmitt Trigger and Sample Oscillator is to set the sample rate of the RCU. Gates U4A through U4D, capacitors C3 and C4, resistors R3, R4, R5 and diodes CR12 and CR16 comprise the Schmitt Trigger and Sample Oscillator circuitry. These are two possible modes of operation for this circuitry: continuous or triggered command mode.

3-121. CONTINUOUS COMMAND MODE. In this mode of operation, 13-25 (EXTERNAL COMMAND ENTRY) and 13-27 (AUTO COMMAND DEFEAT) must be at logic level "1" (+5V dc or open). A "1" command simultaneously present at pin 1 of gate U4A and pin 5 of gate U4B will cause gates U4A, B, C and D to oscillate. The frequency of the oscillation is 3 kHz as determined by R3, C4. Each pulse in the 3 kHz pulse train at pin 8 of U4C acts as the start pulse for counter U2. Thus, commands are updated at a 3 kHz rate. Since this rate is faster than the instrument can respond, command is effectively continuous.

Table 3-5. COUNTER SEQUENCE

STATE	COMMENTS
0000	Oscillator is enabled at this point and count sequence begins.
1000	
1001	
1011	
1010	
1100	
1101	
1110	
1111	
0000	Oscillator is disabled at this point.

3-122. TRIGGERED COMMAND MODE. In this mode 13-27 of operation, 13-37 (AUTO COMMAND DEFEAT) is held at logic level "0" and an external trigger is applied to P13-25 (EXTERNAL COMMAND ENTRY). With a logic level "0" at P13-27 gate U4A is disabled. The application of an external pulse to P13-25 will enable the Schmitt Trigger circuit (gates U4B, C and D) resulting in a negative pulse presented to the counter. As in the continuous command mode, this pulse initiates the command update cycle.

3-123. DIGITAL MULTIPLEXER. The Digital Multiplexer U3 is a medium scale integrated circuit constructed to connect various input signals, one at a time, to a single two-phase output in response to certain input addresses. Table 3-6 defines its operation. The output is serialized into eight time slots; each is 1 μs in length.

3-124. PULSE TRANSFORMER CIRCUITRY. The purpose of this circuitry is to couple the serialized information to the shift register and provide isolation. Gates U1A and U1B pass the serialized information to primaries of pulse transformers T1 and T2 through buffer Q1, Q2, Gate U1A passes logic "1" information, and gate U1B passes Logic "0" information. The secondaries of T1 and T2 impose their respective logic to buffers Q4 and Q5 and thereby to the shift register.

3-125. 8-BIT SHIFT REGISTER MEMORY. J-K flip-flops U7A & B, U8A & B, U9A & B and U10A & B comprise the shift register. Diodes CR6, CR7, resistors R20, R21 comprise the clock network for the flip-flops. The loading of the shift register occurs at pins 2 and 3 of U7A. The logic sequencially shifts through the flip-flops until the last pulse of the loading cycle is loaded into U7A. At this time the shift register is fully loaded and will not change until another loading cycle occurs.

3-126. 8-BIT LATCH BUFFER MEMORY. U11 and latch clock network, transistor Q5, diodes CR10 and CR11 plus capacitor C6, comprise the 8-Bit Latch Buffer Memory circuit. During the loading cycle of the 8-bit shift register memory circuit, transistor Q5 is turned on, which disconnects the inputs of ICU11 to preclude undesirable pulsing of output lines during the loading cycle. After the shift register is fully loaded, transistor Q5 turns off, thereby allowing the outputs of U11 to assume the states of the present inputs.

3-127. DECODERS. Decoder-buffers U12, U13, U14 and transistors Q6 through Q11 decode the U11 latch information to the same format as seen on the input, plus lockout incompatible range/function commands.

3-128. REMOTE FLAG. Remote function is controlled by the remote function line which, when switched to ground, allows Q12 to turn off. When remote function is not desired this line is open so that Q12 will be turned on holding the reset lines low, forcing all eight channels to be in the low state. This will put all the control lines high which is a non-command mode. When the REMOTE function is desired and selected the remote function line (P8-2) is grounded, thereby turning transistor A12 off which commands lamp DSI to extinguish. With DSI extinguished, transistor Q17 appears as a high impedance device which commands transistor Q16 to turn off. When transistor Q16 is turned off the remote flag line (P13-29) is high (+5V) indicating that the Model 8200A is in the REMOTE function.

Table 3-6. MULTIPLEXER OPERATION

IF THE INPUT ADDRESS IS:			THEN OUTPUT PIN 15 HAS THE SIGNIFICANCE	AND OUTPUT PIN 14 HAS THE SIGNIFICANCE	CHANNEL INFORMATION IS:
PIN 13	PIN 12	PIN 11			
0	0	0	R (pin 1)	$\overline{R}$	FUNCTION BIT
0	0	1	N (pin 2)	$\overline{N}$	FUNCTION BIT
0	1	0	L (pin 3)	$\overline{L}$	FUNCTION BIT
0	1	1	K (pin 4)	$\overline{K}$	FILTER
1	0	0	J (pin 5)	$\overline{J}$	EXTERNAL REFERENCE
1	0	1	H (pin 6)	$\overline{H}$	RANGE LSB
1	1	0	G (pin 7)	$\overline{G}$	RANGE BIT
1	1	1	F (pin 9)	$\overline{F}$	RANGE MSB

Section 4
Maintenance

4-1. INTRODUCTION

4-2. This section contains information and instructions concerning preventive and corrective maintenance for the Model 8200A Digital Voltmeter. The information and instructions are arranged under headings of "SERVICE INFORMATION, GENERAL MAINTENANCE, PERFORMANCE TEST, CALIBRATION PROCEDURE, and TROUBLESHOOTING."

4-3. A calibration interval of 90 days is recommended to ensure instrument operation within the 90-day specifications as stated in Section 1.

4-4. Table 4-1 lists the required test equipment. If the recommended equipment is not available, other equipment having equivalent specifications may be used.

Table 4-1. REQUIRED TEST EQUIPMENT

EQUIPMENT NOMENCLATURE	RECOMMENDED EQUIPMENT	FUNCTION
DC Calibrator	Fluke Model 332B DC Calibrator	Performance Test Calibration Troubleshooting
Kelvin Varley Divider	Fluke Model 720A	Calibration
Differential Voltmeter	Fluke Model 885AB	Performance Test Calibration Troubleshooting
Oscilloscope	Tektronix Model 504	Troubleshooting
AC Calibration System	Fluke Models 5200A/5205A	Calibration/ Performance Test
*RC Parallel Network	1 Megohm in parallel with .1μf (mylar)	Troubleshooting Calibration

NOTE*
Housed in standard Pomona shielded dual banana connector.

4-5. SERVICE INFORMATION

4-6. Each instrument that is manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of one year upon delivery to the original purchaser. The WARRANTY is located at the front of the manual.

4-7. Factory authorized calibration and service for each Fluke product is available at various world-wide locations. A complete list of these authorized service centers is located at the rear of the manual. Shipping information is given in Section 2, paragraph 2-3. If requested, an estimate will be provided to the customer before any repair work is begun on instruments that are beyond the warranty period.

4-8. GENERAL MAINTENANCE

4-9. Access/Disassembly

4-10. The following procedure is used to gain access to the interior of the Model 8200A.

a. Remove top dust cover to gain access to calibration adjustments and test points.

b. Remove top guard chassis by removing single screw which holds it in place. Access is now provided to the plug-in assemblies shown in Figure 4-1.

c. Remove bottom dust cover. By removing single screw securing bottom guard cover, access can be gained to the bottom section of the Model 8200A.

4-11. Cleaning

4-12. Clean the instrument periodically to remove dust,

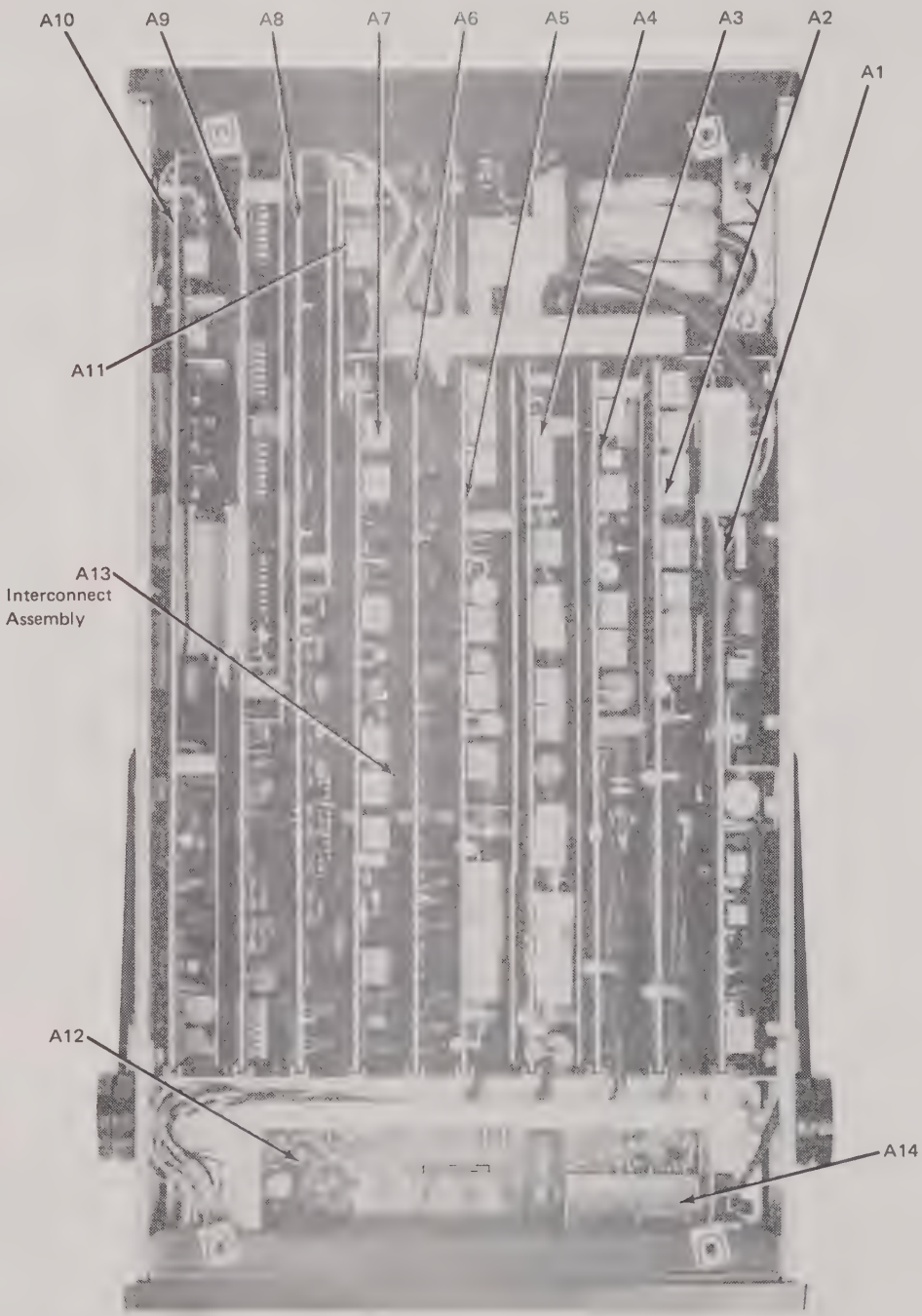


Figure 4-1. ASSEMBLY LOCATIONS

grease, and other contamination. Use the following procedure:

a. Clean the interior with clean, dry air at low pressure. When the printed circuit boards require cleaning, first spray them with Freon T.F. Degreaser (Miller Stephensen Company, Inc.) and then remove the dirt with clean, dry air at low pressure.

NOTE!

The A4 Buffer (8200A-4004) and the A2 Ohms Converter (8200A-4002) assemblies are to be cleaned with only hot water in order to maintain the instrument performance at high humidity.

b. Clean the front panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened in a mild solution of detergent and water.

CAUTION!

Do not use aromatic hydrocarbons or chlorinated solvents on the front panel, because they will react with the Lexan binding posts.

4-13. Fuse Replacement

4-14. One fuse is located in the rear panel fuseholder. When replacement is necessary, install Bussman, TYPE AGC 1/2A as shown on Decal located on the rear panel.

4-15. Lamp and Tube Replacement

4-16. The readout tubes (V1 thru V7) are mounted behind the window portion of the front panel. The function lamps are located behind the front panel on printed circuit boards. These components are replaced without special tools using the following procedure:

4-17. DISASSEMBLY PROCEDURE

a. Remove top and bottom covers.

b. Remove top and bottom guard covers by removing single screws on each.

c. Remove two screws each side of front panel.

d. Remove leads on INPUT HI and LO terminals and remove front panel.

e. Remove five screws securing the A12 Displays assembly to A13 Interconnect assembly. Access is now gained for servicing the A12 Display Assembly.

4-18. READOUT TUBE REPLACEMENT.

a. To replace the readout tubes desolder the base mounting pins, remove and replace defective tube.

CAUTION!

Use a desoldering tool and exercise extreme caution to avoid lifting land patterns.

4-19. FUNCTION LAMPS REPLACEMENT

a. To replace the function lamps desolder the lamp from pcb, remove and replace defective lamp.

4-20. Switch Maintenance

4-21. The following procedure covers service and replacement of the push button switches. If switch contacts are deformed, or if switch module is defective, replacement assemblies can be obtained by ordering either the FUNCTION or FUNCTION/RANGE switch assembly.

4-22. The procedure for servicing the FUNCTION and FUNCTION/RANGE switch assemblies is as follows:

4-23. GENERAL

a. Remove the top and bottom dust covers and the top and bottom inner guard covers.

b. Set all switches to the non-depressed position.

c. Remove two screws from each side of panel.

d. Remove leads on the INPUT terminals and remove front panel.

e. Remove five screws securing the A12 Display assembly to the A13 Interconnect assembly. Access is now gained for servicing the FUNCTION or FUNCTION/RANGE switch assemblies.

4-24. DISASSEMBLY – FUNCTION SWITCH ASSEMBLY

a. Desolder A14 Lamp Assembly from the FUNCTION switch assembly.

b. Remove button on switch to be repaired by ap-

plying pressure to the rear of the button while pulling button away from switch. Note that on some instruments buttons are cemented on the switch shaft. When replacing buttons, use a small amount of contact cement. Apply cement to shaft only.

c. Remove push-push pin and push-push clip. Refer to Figure 4-2.

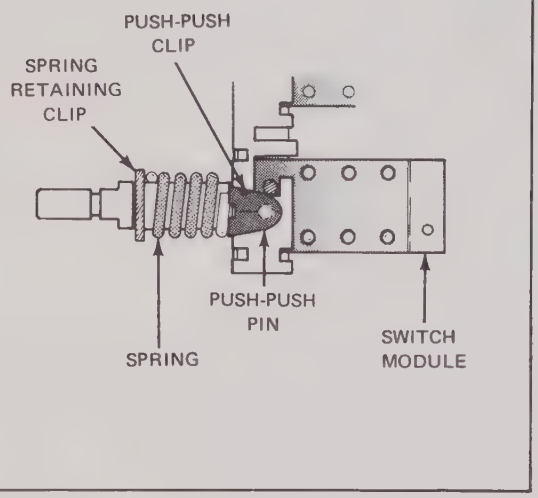


Figure 4-2. FUNCTION SWITCH ASSEMBLY DISASSEMBLY

d. Push defective switch shaft out rear of module. Switch contacts will fall out of their slots when shaft is pushed out of module. Refer to Figure 4-3.

CAUTION!

Under no circumstances MUST attempts be made to re-form or add tension to the switch contacts by bending them.

e. Inspect the switch contacts for contamination and, if necessary, clean them with a clean swab saturated in alcohol. After cleaning, the contacts must be re-coated with a thin coat of grease: Use RYKON 2EP grease (American Oil Co.) or equivalent.

f. Assemble the switch by reversing the foregoing procedure. Exercise extreme caution to ensure the contacts are not deformed during assembly.

4-25. DISASSEMBLY FUNCTION/RANGE SWITCH ASSEMBLY

a. Desolder A15 Lamp Assembly from the FUNCTION switches of the FUNCTION/RANGE switch assembly.

b. Straighten all locking tabs on rear support bracket of switch group that contains defective switch. Refer to Figure 4-4.

CAUTION!

When straightening locking tabs avoid damag- in land patterns on PCB.

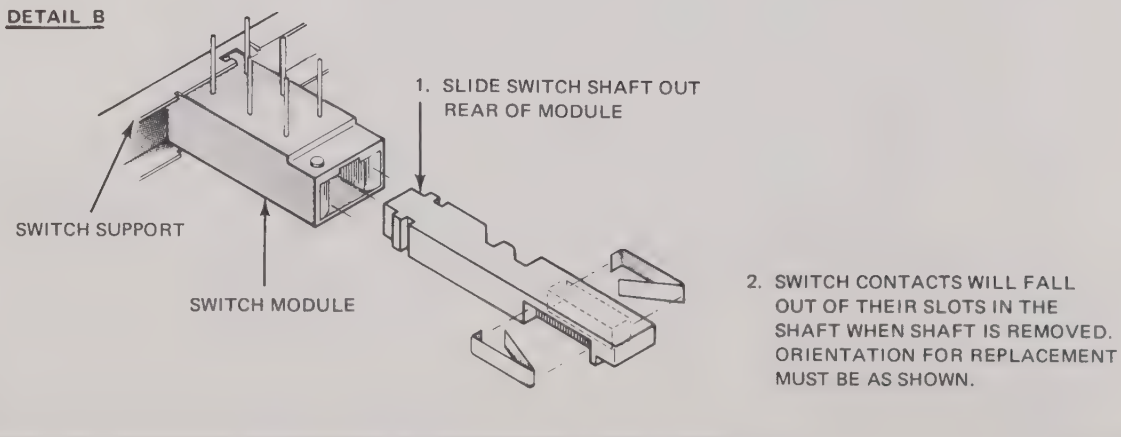

DETAIL B
1. SLIDE SWITCH SHAFT OUT REAR OF MODULE
SWITCH SUPPORT
SWITCH MODULE
2. SWITCH CONTACTS WILL FALL OUT OF THEIR SLOTS IN THE SHAFT WHEN SHAFT IS REMOVED. ORIENTATION FOR REPLACEMENT MUST BE AS SHOWN.

Figure 4-3. PUSHBUTTON SWITCH DISASSEMBLY

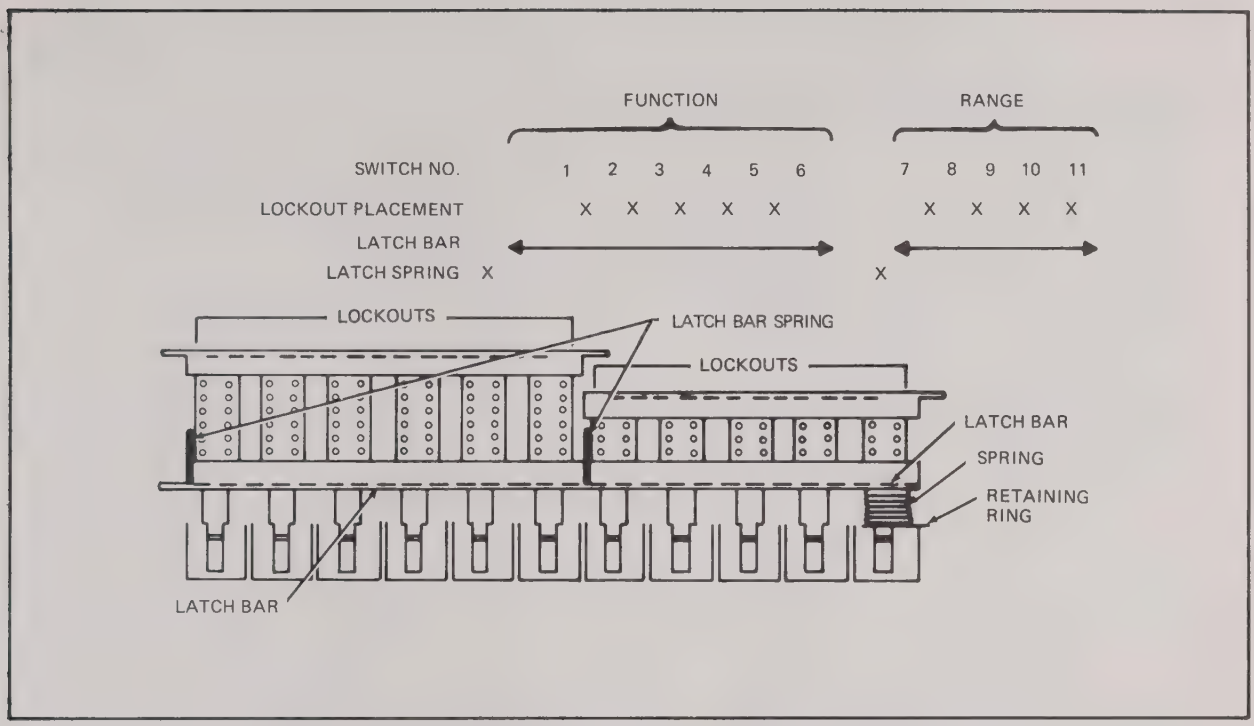


Figure 4-4. FUNCTION/RANGE SWITCH ASSEMBLY

c. Remove rear support bracket by sliding bracket to the right to clear switch module alignment pins. Remove bracket and lockouts.

d. Remove button, retaining ring and spring.

e. Insert a tool between the latch bar and switch shaft on adjacent switch (Figure 4-5).

f. Slide latch bar to edge of opening in front switch support bracket.

g. Holding latch bar open, push defective switch shaft out rear of module. Switch contacts will fall out of their slots when shaft is pushed out of module.

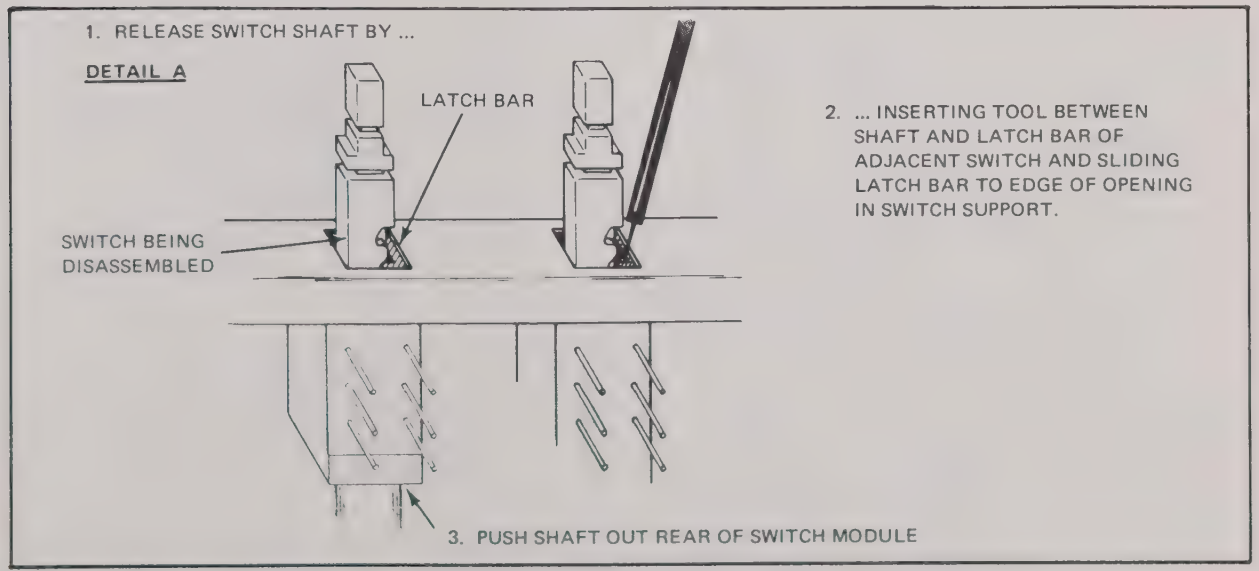

1. RELEASE SWITCH SHAFT BY ...
DETAIL A
LATCH BAR
SWITCH BEING DISASSEMBLED
2. ... INSERTING TOOL BETWEEN SHAFT AND LATCH BAR OF ADJACENT SWITCH AND SLIDING LATCH BAR TO EDGE OF OPENING IN SWITCH SUPPORT.
3. PUSH SHAFT OUT REAR OF SWITCH MODULE

Figure 4-5. FUNCTION/RANGE SWITCH ASSEMBLY DISASSEMBLY

CAUTION!

Under no circumstances MUST attempts be made to re-form or add tension to the switch contacts by bending them.

h. Inspect the switch contacts for contamination and, if necessary, clean them with a cotton swab saturated in alcohol. After cleaning, the contacts must be re-coated with a thin coat of grease: Use RYKON 2EP grease or equivalent.

4-26. SWITCH MODULE REPLACEMENT – FUNCTION ASSEMBLY

a. Repeat paragraphs 4-23.

b. Desolder A14 Lamp Assembly from the FUNCTION switch assembly.

CAUTION!

Use a desoldering tool and exercise extreme caution to avoid lifting land patterns or otherwise damaging the printed circuit assembly.

c. Remove buttons, retaining clip, and spring from all four switches.

d. Remove push-push clip and pin from the three FUNCTION switches.

CAUTION!

Any depression on the switch shafts will cause switch shaft to slide out the rear of the module.

e. Unlock the locking tab on front switch support bracket (Figure 4-6) and slide bracket past alignment peg, then pull bracket off of modules.

f. Desolder defective module from A12 Display PCB.

CAUTION!

Use a desoldering tool and exercise extreme caution to avoid lifting land patterns or otherwise damaging the printed circuit assembly.

g. Install new switch module by reversing the foregoing procedure.

CAUTION!

Under no circumstances MUST attempts be made to re-form or add tension to the switch contacts by bending them.

4-27. SWITCH MODULE REPLACEMENT – FUNCTION/ASSEMBLY

a. Repeat paragraphs 4-23.

b. Desolder A15 Lamp Assembly from the FUNCTION switches.

c. Remove all buttons, retaining rings, springs and latch spring on FUNCTION and RANGE switches.

d. Unlock all locking tabs on front support bracket and remove front support bracket and latch bar.

e. Straighten all locking tabs on rear support bracket of switch assembly containing defective module.

CAUTION!

When straightening locking tabs avoid damaging land patterns on PCB.

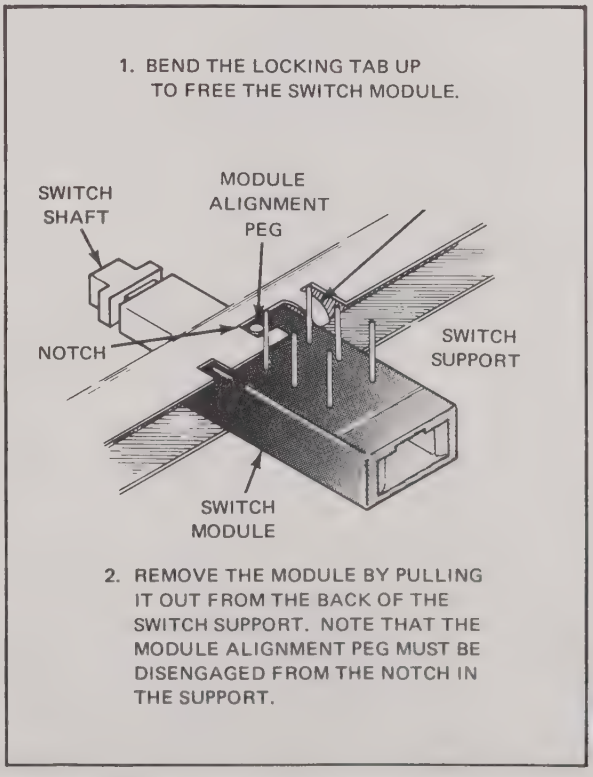

1. BEND THE LOCKING TAB UP TO FREE THE SWITCH MODULE.
SWITCH SHAFT
MODULE ALIGNMENT PEG
NOTCH
SWITCH SUPPORT
SWITCH MODULE
2. REMOVE THE MODULE BY PULLING IT OUT FROM THE BACK OF THE SWITCH SUPPORT. NOTE THAT THE MODULE ALIGNMENT PEG MUST BE DISENGAGED FROM THE NOTCH IN THE SUPPORT.

Figure 4-6. FUNCTION SWITCH ASSEMBLY REPLACEMENT

f. Remove rear support bracket and desolder defective module.

CAUTION!

Use a desoldering tool and exercise extreme caution to avoid lifting land patterns or otherwise damaging PCB.

g. Install new switch module by reversing foregoing procedure. Refer to Figure 4-4 for assembly of FUNCTION/RANGE switch assembly.

4-28. PERFORMANCE TEST

4-29. Introduction

4-30. The section contains the performance tests for the basic instrument and options. The performance tests compares the performance of the basic instrument and options to the accuracy specifications in Section 1 of this manual to determine if the instrument is in calibration. The performance tests should be conducted prior to any instrument maintenance or calibration attempts. These tests are also suited to receiving inspection of new instruments. The performance tests should be conducted under the following conditions: Ambient Temperature 23°C ± 5°C, Relative Humidity less than 70%.

4-31. Should an instrument fail the performance test, corrective maintenance or calibration will be required. In case a trouble occurs, analysis of the test results, with reference to the Troubleshooting Section, should help to locate the trouble.

4-32. Basic Instrument

4-33. Known dc voltages are applied to the instrument INPUT terminals at 10% and 100% of full-scale on the 1, 10, 100, and 1000 volt ranges.

NOTE!

Tolerance for dc voltage measurements are derived from the 90-day instrument specifications contained in Section 1 of this manual.

4-34. PRELIMINARY OPERATION

a. Connect the Model 8200A to the ac line and set the controls as follows:

POWER	ON
FUNCTION	VDC, FILTER
RANGE	1

4-35. READOUT CHECKS

a. Connect a shorting jumper between the INPUT terminals.

b. Readout ±.0000 ±1 digit.

c. Connect dc calibrator to the Model 8200A and apply each of the input voltages shown in Table 4-2 to the INPUT terminals of the Model 8200A. The readout must be as indicated.

d. Repeat step c. with negative input voltages. The DVM readout must be the same as for positive inputs, except that the polarity indication will be negative (−).

e. Apply zero volts to the INPUT terminals of the DVM and depress the AUTO RANGE switch. The readout must be 0000 ±1 digit.

TABLE 4-2. DC TEST REQUIREMENTS

INPUT VOLTS	MODEL 8200A		
	RANGE	READOUT LIMITS	READOUT TOLERANCES
1.0	1	+0.9998 to 1.0002	±2 digits
10.	10	+9.998 to 10.002	±2 digits
10.	100	+09.99 to 10.01	±1 digit
100.	100	+99.98 to 100.02	±2 digits
1000.	1000	+999.8 to 1000.2	±2 digits

NOTE!

If MV Converter (–02 Option) is installed, unit will autorange to 10 MV range.

f. Apply +1000.00 volts dc to the INPUT terminals. The DVM must range automatically and the readout must be +1000.00 ±2 digits.

4-36. FILTER CHECK

a. Set the Model 8200A front panel controls as follows:

FUNCTION	VDC, FILTER
RANGE	1

b. Apply 6.3V ac ±.1V ac at 100 Hz to Model 8200A INPUT terminals.

c. Readout .0000 ±.0010 on Model 8200A display.

4-37. Options

4-38. The performance tests for determining if an instrument containing options is in calibration are as follows:

4-39. A5 AC CONVERTER (–01 OPTION) AND A28 TRUE RMS CONVERTER (–09 OPTION)

a. Set the Model 8200A front panel controls as follows:

FUNCTION	VAC
RANGE	Manually selected, as required.

b. Apply each of the 10 kHz test signals shown in Table 4-3 to the INPUT terminals of the Model 8200A. The readout should be within indicated tolerances.

Table 4-3. AC VOLTAGE TEST REQUIREMENTS

INPUT (VAC)	MODEL 8200A	
	RANGE	READOUT LIMITS *
1	1	±12 digits (24)
10	10	±12 digits (24)
100	100	±12 digits (24)
1	1000	±12 digits (24)
1000	1000	±15 digits (36)

* *True RMS Converter limits in paranthes using FILT/RMS mode.*

c. Disconnect test equipment.

4-40. A3 MILLIVOLT (–02 OPTION)

a. Set the Model 8200A front panel controls as follows:

FUNCTION	MVDC, FILTER
RANGE	10

b. Connect a shorting jumper between INPUT terminals.

c. Adjust the front panel MV ZERO control for a minimum reading on the Model 8200A display.

d. Connect equipment as shown in Figure 4-7.

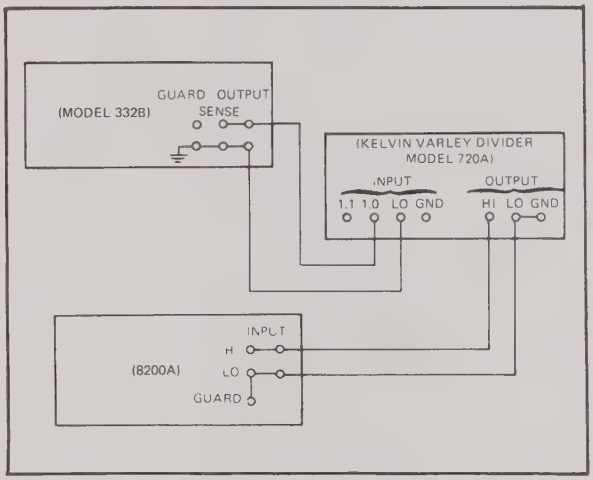


Figure 4-7. READOUT CHECK EQUIPMENT CONNECTION

e. Set the calibrator to 1.0000V output on 10V range.

f. Refer to Table 4-4 for K-V divider settings and corresponding readout limits on Model 8200A.

Table 4-4. MVDC CHECK

SETTINGS	MODEL 8200A	
	RANGE	READOUT LIMITS
.001000	10	±2 digits
.010000	10	±3 digits
.010000	100	±1 digit
.100000	100	±2 digits

g. Reverse input leads to Model 8200A.

h. Repeat step f. The Model 8200A readout must be the same as for positive inputs, except that the polarity indication will be negative (–).

4-41. A2 OHMS CONVERTER (–03 OPTION)

a. Set the Model 8200A front panel controls as follows:

FUNCTION	Ω
RANGE	Manually selected, as required

b. Connect each of the standard resistors in Table 4-5 across the INPUT terminals of the Model 8200A and verify appropriate readout on display.

Table 4-5. OHMS CONVERTER CHECK

STANDARD RESISTANCE VALVE	MODEL 8200A		
	FUNCTION	RANGE	READOUT LIMITS
100Ω	Ω	100	±5 digits
1kΩ	kΩ	1	±1 digit
10kΩ	kΩ	10	±1 digit
100kΩ	kΩ	100	±1 digit
1 MegΩ	KΩ	1000	±4 digits
10 MegΩ	MΩ	10	±12 digits

4-42. A11 EXTERNAL REFERENCE (–04 OPTION)

a. Connect the dc voltage source to the Model 8200A as shown in Figure 4-8.

b. Set the Model 8200A controls as follows:

POWER	ON
FUNCTION	EXT REF, VDC
RANGE	10

c. Set the dc voltage source controls for 10 volt dc output.

d. The Model 8200A readout should be +10.000 ±0.006.

4-43. A16 PRINTER OUTPUT (–06 OPTION)

a. Set the Model 8200A front panel controls as follows:

FUNCTION	VDC, FILTER
RANGE	1

b. Apply logic level "1" or open to AUTO TRIG DISABLE line P18-14.

c. Connect external printer to the Printer Output connection.

d. Apply dc voltages given in Table 4-6 and verify appropriate response on printer.

e. Perform steps 1 through 6 of Table 4-7 to check range, polarity, and function response.

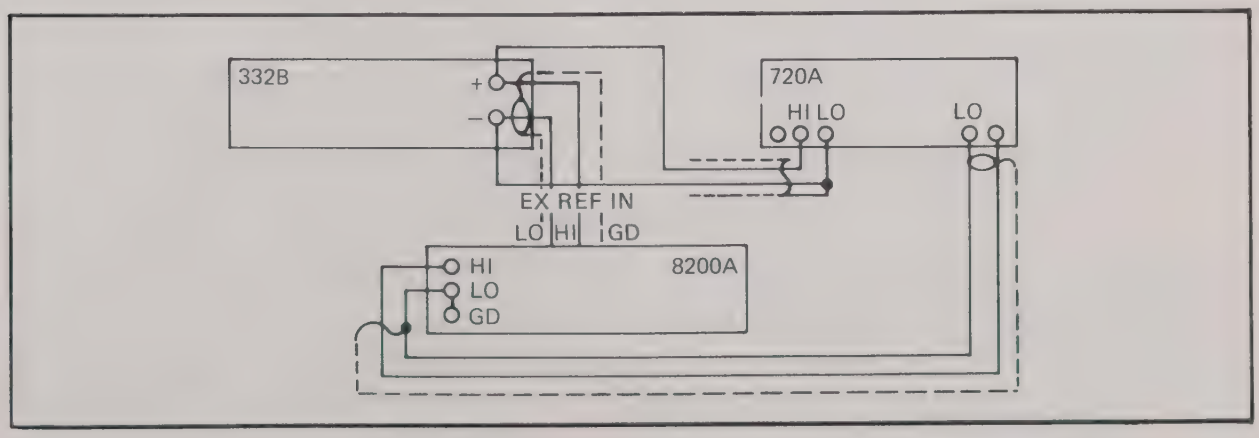


Figure 4-8. EQUIPMENT CONNECTIONS FOR EXTERNAL REFERENCE CHECK

Table 4-6. PRINTER OUTPUT DIGIT CHECK

INPUT VOLTAGE	PRINTER DISPLAY
.00000	0000
.00010	0001
.00020	0002
.00040	0004
.00080	0008
.00180	0018
.00280	0028
.00480	0048
.00880	0088
.01080	0108
.02080	0208
.04080	0408
.08080	0808
.10080	1008
.20080	2008
.40030	4008
.80080	8008

4-45. Digits Registration

a. Set Model 8200A controls as follows:

FUNCTION	VDC
RANGE	10

b. Connect external equipment to output lines on Data Output Units No. 1 and No. 2.

c. Connect a +1.111 volt dc test signal to the INPUT terminals.

d. Command the DVM to take a reading. The DOU output and the front panel display should indicate DC +1.111.

e. Repeat steps (c) and (d) for test signal inputs of +2.222, +4.444, and +8.888 volts dc. The DOU output and front panel display should correspond.

Table 4-7. PRINTER OUTPUT RANGE, POLARITY AND FUNCTION CHECK

STEP	INPUT VOLTAGE	FUNCTION DEPRESSED	RANGE DEPRESSED	DISPLAY	FUNCTION INDICATOR
1	−2.0	VDC	1	−1.5999	on
2	+2.0	VDC	1	+1.5999	on
3	+2.0	MΩ	10	+15.999	off
4	+2.0	Ω	100	+159.99	off
5	+2.0	VAC	1000	+000.2±.2	on
6	+2.0	KΩ	1000	+1599.9	on

f. Apply an external trigger to P18-13, and note change in sample rate.

NOTE!

External trigger can be pulses of 0 to 5 volts, or square wave the rate of which must be less than 400 pulses per second.

4-44. A9 and A10 DATA OUTPUT UNIT (−07 OPTION)

4-46. Overload Indicator.

a. Set Model 8200A controls as follows:

FUNCTION	VDC
RANGE	10

b. Connect a +20 volt dc test signal to the INPUT terminals.

c. Command the DVM to take a reading by applying one external sample pulse. The DOU outputs and front panel display should indicate dc +15.999 and OVERload.

4-47. Function Registration.

a. Set Model 8200A controls as follows:

FUNCTION	VAC
RANGE	100

b. Short the INPUT terminals.

c. Apply one external sample pulse. The DOU outputs and front panel display should indicate VAC and a readout of 00.00 ±2 digits.

d. Repeat steps (a) through (c) for each of the following DVM functions. The DOU output and front panel display should be as indicated.

FUNCTION	DOU OUTPUT/DVM DISPLAY
KΩ	KΩ, 00.00
10Ω	Ω, 0.000
VDC, FILTER	VDC, 0.00
EXT REF	FILTER, EXT REF

4-48. Output Gates.

a. Set Model 8200A controls as follows:

FUNCTION	VDC
RANGE	10

b. Connect a −0.001 volt dc test signal to the INPUT terminals.

c. Command the DVM to take a reading. The DOU output and DVM display should indicate −0.001 ±2 digits.

d. Short all of the following DOU output gate terminals to ground A10P18-24. The DOU output should be as indicated.

GATE TERMINALS (PIN AND CONNECTOR)	DOU OUTPUT
A10P18-2	VDC, MVDC, VAC, FILTER
A10P18-4	Ω, KΩ, MΩ, OVERLOAD,
A10P-15	EXT REF and readout of
A9P14-2	1555.55
A9P14-25	
A9P14-19	
A9P14-13	
A9P14-4	

4-49. Programmed One-Shot.

a. Set the Model 8200A controls as follows:

FUNCTION	VDC, FILTER
RANGE	100

b. Connect oscilloscope to ready line, A10P18-17 of DOU output connector. Command instrument to sample. Delay length should be 530 ±60 milliseconds.

c. Set the function and range controls as follows: The delay lengths should be as indicated.

	POS Operative	Function Calls	Range Call	Observe Length (ms)
a.	Yes	VDC, Filt	10	530 ±60 ms
b.	"	VAC, Filt	10	850 ±90 ms
c.	"	Ω, Filt	100	560 ±60 ms
d.	"	KΩ, Filt	100	1.3 ±.15 sec
e.	"	MVDC, FILTER	100	2.1 ±.25 sec
f.	"	MΩ, FILTER	10	7.4 ±,8 sec
g.	"	MVDC	10	120 ±15 ms
h.	"	VDC	100	15 ±2 ms
i.	"	MΩ	10	44 ±5 ms
j.	"	Ω	100	16 ±2 ms
k.	"	KΩ	100	17 ±2 ms

4-50. A8 REMOTE CONTROL (−08 OPTION)

a. Depress REMOTE button on Model 8200A front panel.

b. Activate each of the combinations of functions and ranges shown in column 1 of Figure 4-9 by contact closure between the appropriate pin and common of the RCU connector (refer to Table 2-12 of Section 2 for connector pin assignments). Observe the resulting front panel display and verify correct response for each call combination listed in Figure 4-9.

4-51. CALIBRATION PROCEDURE

4-52. Introduction

4-53. The basic Model 8200A should be calibrated every 90 days or 1 year in order to maintain rated accuracy or whenever repairs have been made. Calibration should be done under the following conditions: Ambient Temperature of 23°C ±2°C, relative humidity less than 70%. Refer to Table 4-1 for recommended test equipment. Adjustment

Functions Called	Range Called	8200A-Inst. Inputs	8200A Response
MVDC, FILTER, EXT. REF.	10	Shorted	10 MVDC, FILTER, EXT. REF.
MVDC, FILTER, EXT. REF.	100	"	100 MVDC, FILTER, EXT. REF.
VDC, FILTER, EXT. REF.	1	"	1 VDC, FILTER, EXT. REF.
VDC, FILTER, EXT. REF.	10	"	10 VDC, FILTER, EXT. REF.
VDC, FILTER, EXT. REF.	100	"	100 VDC, FILTER, EXT. REF.
VDC, FILTER, EXT. REF.	1000	"	1000 VDC, FILTER, EXT. REF.
Ω, FILTER, EXT. REF.	100	"	100Ω, FILTER, EXT. REF.
kΩ, FILTER, EXT. REF.	1	"	1kΩ, FILTER, EXT. REF.
kΩ, FILTER, EXT. REF.	10	"	10kΩ, FILTER, EXT. REF.
kΩ, FILTER, EXT. REF.	100	"	100kΩ, FILTER, EXT. REF.
kΩ, FILTER, EXT. REF.	1000	"	1000kΩ, FILTER, EXT. REF.
MΩ, FILTER, EXT. REF.	10	"	10MΩ, FILTER, EXT. REF.
VAC, FILTER, EXT. REF.	1	"	1 VAC, EXT. REF.
VAC, FILTER, EXT. REF.	10	"	10 VAC, EXT. REF.
VAC, FILTER, EXT. REF.	100	"	100 VAC, EXT. REF.
VAC, FILTER, EXT. REF.	1000	"	1000 VAC, EXT. REF.

Figure 4-9. REMOTE CONTROL UNIT TEST REQUIREMENTS

and test point locations are labeled on the top inner guard cover. Figure 4-10 shows adjustment and test point locations with the top inner guard cover on.

4-54. Basic Instrument (less options)

4-55. PRELIMINARY OPERATIONS

a. Remove the top outer and guard covers.

b. Set the 115/230 volt switch to 115, install top guard cover, and then connect line cord to the output of an autotransformer set to 115V ac.

c. Turn on the Model 8200A and allow it to warm-up for one hour.

4-56. REFERENCE VOLTAGE ADJUSTMENT

Select 1V Range
VDC Filter

b. Remove top guard cover.

c. Set the Model 8200A controls as follows:

d. Connect the differential voltmeter to GND TP (A7TP1) and +7V TP (A7TP2).

e. Adjust +7V TP (A7R7) for a reading of 7.0000 ±100 uV on the differential voltmeter.

4-57. BUFFER ZERO ADJUSTMENT

a. Short the INPUT terminals.

b. Connect differential voltmeter between INPUT LO (–) and A4TP2 (+).

c. Adjust VDC ZERO (A4R23) for zero readout on differential voltmeter ±10 μV.

d. Remove short across INPUT terminals and remove differential voltmeter.

4-58. (–) ZERO ADJUSTMENT

a. Install top guard cover and secure with retaining screw.

b. Short A6TP2 to A6TP3.

NOTE!

These test points are designated on the top guard cover SHORT TEST POINTS FOR CONTINUOUS MEASURE.

c. Apply –.00055 vdc from calibrator to INPUT terminals on Model 8200A.

d. Adjust (–) ZERO (A7R27) until the last digit in the readout alternates uniformly between 5 and 6.

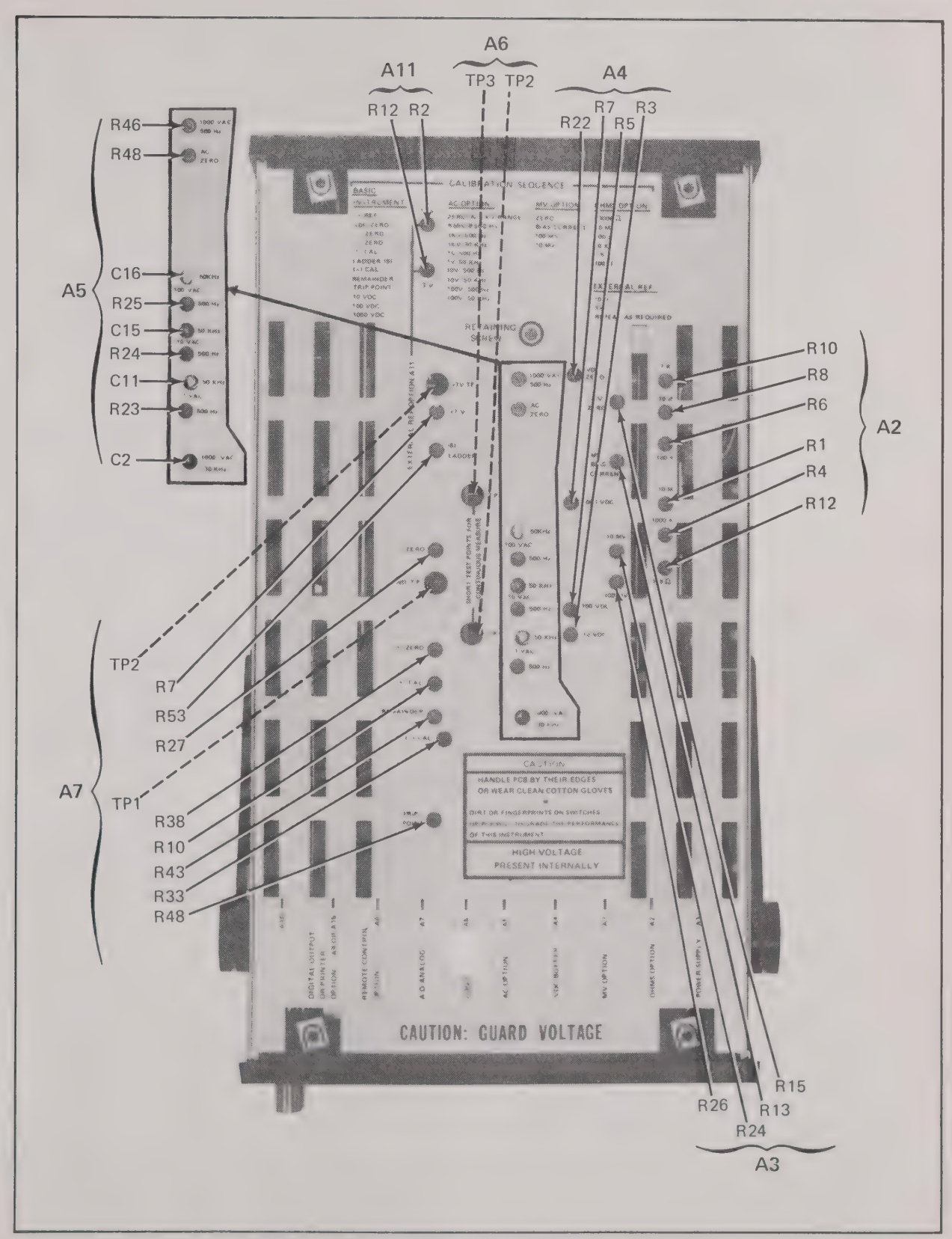


Figure 4-10. ADJUSTMENT AND TEST POINT LOCATIONS

4-59. (+) ZERO ADJUSTMENT

a. Apply +.00055 vdc from calibrator to INPUT terminals on Model 8200A.

b. Adjust (+) ZERO (A7R38) until the last digit in the readout alternates uniformly between 5 and 6.

4-60. (+) CAL ADJUSTMENT

a. Apply +.70055 vdc from calibrator to INPUT terminals of Model 8200A.

b. Adjust (+) CAL (A7R10) until the last digit in the readout alternates uniformly between 5 and 6.

4-61. (8) LADDER ADJUSTMENT

a. Apply +.80055 vdc from calibrator to INPUT terminals of Model 8200A.

b. Adjust (8) LADDER (A7R53) until the last digit in the readout alternates uniformly between 5 and 6.

4-62. (–) CAL ADJUSTMENT

a. Apply –.70055 vdc from calibrator to INPUT terminals of Model 8200A.

b. Adjust (–) CAL (A7R33) until the last digit in the readout alternates uniformly between 5 and 6.

4-63. REMAINDER ADJUSTMENT

a. Apply +.09955 from calibrator to INPUT terminals of Model 8200A.

b. Adjust REMAINDER (A7R43) until the last digit in the readout alternates uniformly between 5 and 6.

c. Apply –.09955 from calibrator to INPUT terminals.

d. Readout –.0995/6 on Model 8200A and note that the last digit in the readout alternates uniformly between 5 and 6.

4-64. TRIP POINT ADJUSTMENT

a. Apply +.09995 vdc from calibrator to INPUT terminals on Model 8200A.

b. Readout +.0999 on Model 8200A.

c. Adjust TRIP POINT (A7R48) until readout alternates between +.0999 and +.1000.

d. Reverse input voltage to Model 8200A and note that the readout on Model 8200A alternates between –.0999 and –.1000.

e. Alternately, apply + and –1.09995 vdc from calibrator to INPUT terminals of Model 8200A.

f. Verify that readout alternates between 1.0999 and 1.1000 for both polarities of input voltage.

4-65. RANGE ADJUSTMENT

a. Connect calibrator to the Model 8200A INPUT terminals.

b. Sequentially apply the input voltages given in Table 4-8 and perform the associated adjustment that produces the required readout on the Model 8200A.

Table 4-8. RANGE CALIBRATION

STEP NO.	VOLTAGE	RANGE	MODEL 8200A ADJUSTMENT	READOUT
1	+10.0055	10	10 VDC (A4R3)	*10.005/6
2	+100.055	100	100 VDC (A4R5)	100.05/6
3	+1000.55	1000	1000 VDC (A4R7)	1000.5/6
NOTE* Calibration adjustment is set so last digit in readout alternates between 5 and 6.				

c. Disconnect calibrator from Model 8200A and install outer top cover. Calibration of the basic Model 8200A is complete. Option calibration is included in the following paragraph.

4-66. Options

4-67. Calibration of the Options is done using the following procedures. All unmentioned options do not require calibration. Required test equipment is listed at the beginning of each procedure. Most adjustments and test points are labeled on the top guard cover.

NOTE!

The basic instrument must be calibrated (paragraph 4-51 through 4-65) before options are calibrated.

4-68. AC CONVERTER (–01 OPTION).* Calibration of the –01 Option requires an ac voltage standard such as the Fluke 5200A/5205A.

a. Select VAC FUNCTION and 1000V RANGE.

b. Connect a shorting jumper between A6TP2 and TP3 to establish continuous measurement mode.

c. Apply a 9.55V rms, 500 Hz, signal to the INPUT HI and LO terminals.

d. Adjust A5R48 (AC ZERO) until the last digit in the readout alternates uniformly between 5 and 6.

e. Remove rms input and connect a shorting jumper between the INPUT HI and LO terminals.

f. Select 1V RANGE, observing that readout is 0000 ±5 digits.

g. Remove the shorting jumper between the INPUT terminals and A6TP2 and TP3.

h. Apply the rms input voltages on the ranges indicated in Table 4-9. Adjust or check readout for indication corresponding to rms input. Tolerances are given for least significant digit.

i. Disconnect test equipment. Calibration of the –01 Option is completed.

4-69. MILLIVOLT (–02 OPTION). Calibration of the –02 Option requires the following test equipment:

FLUKE Model 332B DC Voltage Standard.

FLUKE Model 720A K-V Divider.

a. Select MVDC and FILTER FUNCTION and 10 MVDC RANGE.

b. Connect a shorting jumper between the INPUT HI and LO terminals.

c. Rotate MV ZERO control (accessible through front panel) throughout its range, observing that the readout changes ±70 digits. If necessary, adjust A3R15 (MV ZERO) to provide a ±70 digit range for the front panel MV ZERO control.

d. Connect a shorting jumper between A6TP2 and TP3 to establish continuous measurement mode.

e. Adjust front panel MV ZERO control until the + and – signs in the readout alternate uniformly.

f. Remove shorting jumper between INPUT terminals.

g. Connect a shielded, parallel network consisting of a 1M resistor and a 0.1 uf capacitor between the

Table 4-9. AC CONVERTER ADJUSTMENTS AND CHECKS

INPUT VOLTAGE (RMS)	INPUT FREQ	RANGE	ADJUSTMENT	8200A CKT. DESIG.	READOUT TOLERANCE (lowest digit)
500.0	500 Hz	1000	1000 - L.F.	R46	±1 digit
500.0	30 kHz	1000	1000 - H.F.	C2	±1 digit
1.0000	500 Hz	1	1 - L.F.	R23	±1 digit
1.0000	50 kHz	1	1 - H.F.	C11	±1 digit
.001	50 kHz	1	Check	–	±2 digit
1.0000	100 kHz	1	Check	–	±30 digits
1.0000	20 kHz	1	Check	–	±5 digits
1.0000	50 Hz	1	Check	–	±7 digits
10.000	500 Hz	10	10 - L.F.	R24	±1 digit
10.000	50 kHz	10	10 - H.F.	C15	±1 digit
100.00	500 Hz	100	100 - L.F.	R25	±1 digit
100.00	50 kHz	100	100 - H.F.	C16	±1 digit
1000.00	10 kHz	1000	Check (wait 30 sec)	–	±10 digits

** Note: See section 6 for calibration instructions for True RMS Converter (–09 Option).*

INPUT HI and LO terminals. Adjust A3R13 (MV BIAS CURRENT) for 0.0000 ±5 digit readout.

h. Connect a shorting jumper between the INPUT HI and LO terminals. Adjust A3R15 (MV ZERO) until the + and − signs in the readout alternate uniformly.

i. Repeat steps f through h until the specified results are obtained.

j. Remove shorting jumper between INPUT HI and LO terminals.

k. Connect equipment as shown in Figure 4-11.

p. Select 10 MVDC RANGE and then adjust front panel MV ZERO until the + and − sign in the readout alternate uniformly.

q. Set the voltage standard output to +1V and record the 8200A readout. Reverse output polarity of voltage standard and compare 8200A readout to previous readout. If readouts are different, adjust front panel MV ZERO to compensate.

r. Set voltage standard output to +1V and adjust A3R26 (10 MV) for a readout of +10.000 ±2 digits.

s. Reverse voltage standard output polarity (−1V), observing that the readout is −10.000 ±2 digits.

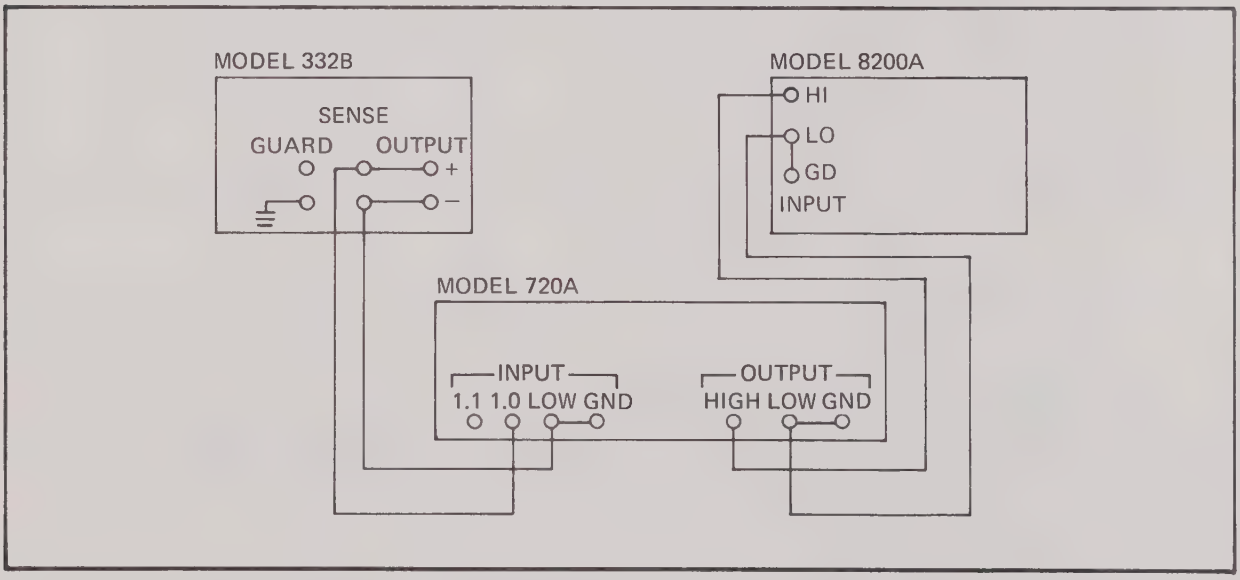


Figure 4-11. MV CONVERTER CALIBRATION CONNECTION

l. Set the voltage standard output to 0V and the K-V divider to .100000. Adjust front panel MV ZERO until the + and − sign in the readout alternate uniformly.

m. Select the 100 MVDC RANGE and then set the voltage standard output to +1V. Adjust A3R24 (100 MV) for a readout of +100.00 ±2 digits.

n. Reverse voltage standard output polarity (−1V), observing that the readout is −100.00 ±2 digits.

o. Set voltage standard output to 0V and the K-V divider to .010000.

t. Disconnect the test equipment. Calibration of the −02 Option is completed.

4-70. OHMS (−03 OPTION). Calibration of the −03 Option requires the use of the following calibrated resistance at 23°C ±5°C:

100Ω ±0.01%

1K ±0.0035%

10K ±0.0035% 1M ±0.007%

100K ±0.0035% 10M ±0.03%

NOTE!

Calibrated resistances include lead resistance and contact resistance to INPUT terminals of 8200A.

a. Select KΩ and FILTER FUNCTION and 1000 RANGE.

b. Connect a shorting jumper between A6TP2 and TP3 to establish continuous measurement mode.

c. Connect 1M resistance to INPUT terminals and adjust A2R4 (1000K) for a readout which corresponds to the exact value of the input resistance.

d. Disconnect 1M resistance and select MΩ FUNCTION and 10 RANGE.

e. Connect 10M resistance to INPUT terminals and adjust A2R1 (10M) for a readout which corresponds to the exact value of input resistance. Allowable tolerance is ±1 digit in the lowest readout digit.

f. Disconnect 10M resistance and select KΩ FUNCTION and 100 RANGE.

g. Connect 100k resistance to INPUT terminals and adjust A2R6 (100k) for a readout which corresponds to the exact value of input resistance.

h. Disconnect 100k resistance and select 10 RANGE.

i. Connect 10k resistance to INPUT terminals and adjust A2R8 (10k) for a readout which corresponds to the exact value of input resistance.

j. Disconnect 10k resistance and select 1 RANGE.

k. Connect 1k resistance to INPUT terminals and adjust A2R10 (1k) for a readout which corresponds to the exact value of input resistance.

l. Disconnect 1k resistance and select Ω FUNCTION and 100 RANGE.

m. Connect 100Ω resistance to INPUT terminals and adjust A2R12 (100Ω) for a readout which corresponds to the exact value of input resistance.

n. Disconnect the test equipment. Calibration of the −03 Option is completed.

4-71. EXTERNAL REFERENCE (−04 OPTION). Calibration of the −04 Option requires the following test equipment:

FLUKE Model 332B DC Voltage Standard.

FLUKE Model 720A K-V Divider.

a. Select VDC, FILTER, and EXT REF FUNCTIONS and 1V RANGE.

b. Connect a shorting jumper between A6TP2 and TP3 to establish continuous measurement mode.

c. Connect equipment as shown in Figure 4-12.

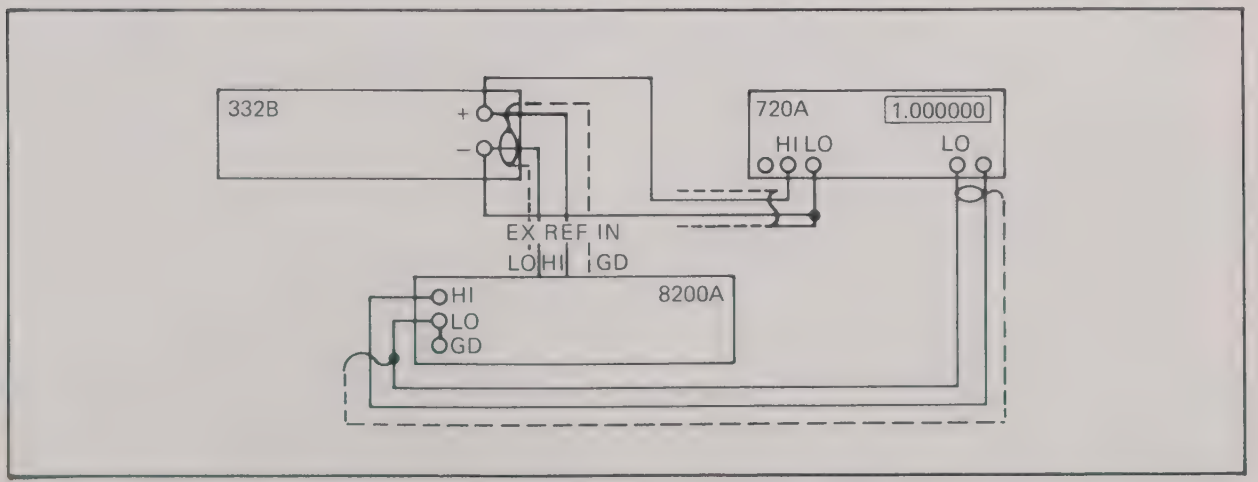


Figure 4-12. EQUIPMENT CONNECTIONS FOR EXTERNAL REFERENCE UNIT CALIBRATION

d. Set the K-V divider to .100055 and the voltage standard output to +10V.

e. Adjust A11R12 (10V) until the last digit in the readout alternates uniformly between 5 and 6.

f. Set the voltage standard output to +3V and adjust A11R12 (3V) until the last digit to the readout alternates uniformly between 5 and 6.

g. Repeat steps d. through f. until the specified results are obtained.

h. Disconnect the test equipment. Calibration of the –04 Option is completed. The top guard cover and dust cover can now be installed.

4-72. DATA OUTPUT UNIT (–07 Option). Calibration of the –07 Option is as follows:

a. Connect differential voltmeter (+) to A10TP3 and (–) to A10TP2.

b. Adjust A10R36 (5V ADJ) for 5.25 ±1V dc.

c. This completes the calibration of the Data Output Unit (–07) Option).

4-73. TROUBLESHOOTING

4-74. Introduction

4-75. The information contained within this subsection is provided to assist in locating troubles in the Model 8200A. All troubleshooting procedures and information can be found in the schematic diagram section of this manual. The initial troubleshooting procedure and section localization is given in Drawing No. 8200A-1800. Detailed troubleshooting procedures for each assembly are located on fold out pages facing the appropriate schematic diagrams. The following table lists the troubleshooting procedures as they appear in the Schematic Diagram Section.

Table 4-10. TROUBLESHOOTING PROCEDURES

TITLE	DRAWING NO.
Initial Troubleshooting Procedure	8200A-1800
A1 Power Supply Troubleshooting Procedure	8200A-1801
A2 MV Converter Troubleshooting Procedure	8200A-1802
A3 Ohms Converter Troubleshooting Procedure	8200A-1803
A4 Buffer Troubleshooting Procedure	8200A-1804
A5 AC Converter Troubleshooting Procedure	8200A-1805
A6 Logic Control Troubleshooting Procedure	8200A-1806
A7 A/D Analog Troubleshooting Procedure	8200A-1807
A8 Remote Control Troubleshooting Procedure	8200A-1808
A9 Data Output Unit No. 1 Troubleshooting Procedure	8200A-1809
A10 Data Output Unit No. 2 Troubleshooting Procedure	8200A-1810
A11 External Reference Troubleshooting Procedure	8200A-1811
A12 Display Assembly Troubleshooting Procedure	8200A-1812
A13 Interconnect Assembly Troubleshooting Procedure	8200A-1813
A14 Printer Output Unit Troubleshooting Procedure	8200A-1816
A28 True RMS Converter Troubleshooting Procedure	8200A-1828

Section 5
List of Replaceable Parts

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown list of the instrument and a Cross Reference List of FLUKE stock numbers to original MANUFACTURERS' part numbers. It also lists recommended spare parts and contains part ordering information.

5-3. The parts list shows the location of all assemblies and the replaceable components. Major assemblies are identified by a designation beginning with the letter A followed by a number (e.g., A1 etc). Subassemblies are identified in the same manner; however, the parent assembly designator precedes this designator (e.g., A1A1 etc.). Electrical components are identified by their schematic diagram designator and listed hardware parts are identified by the FLUKE stock number. All listed components are described, and the FLUKE stock number is given. The original MANUFACTURER's part number for each listed item is given in the Cross Reference List at the rear of this section.

5-4. PARTS LIST COLUMN DESCRIPTIONS

a. The REF DESIG column indexes the item description to the associated illustration. In general the reference designations are listed under each assembly in alpha-numeric order. Subassemblies of minor proportions are sometimes listed with the assembly of which they are a part. In this case, the reference designations may appear out of order.

b. The DESCRIPTION column describes the salient characteristics of the component. Indention of the description indicates the relationship to other assemblies, components, etc. In many cases it is necessary to abbreviate in this column. For abbreviations and symbols used, refer to Appendix B located at the rear of the manual.

c. The six-digit part number, by which the item is identified at the John Fluke Mfg. Co., Inc. is listed in the STOCK NO. column. Use this number when ordering parts from the factory or authorized representatives. In the case where a flag note is used, special ordering is required. Flag note explanations are located as close as possible to the flag note.

d. The TOT QTY column lists the total quantity of the item used in each particular assembly. Second and subsequent listings of the same item are referenced to the first listing with the abbreviation REF.

e. Entries in the REC QTY column indicate the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of

each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc. that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.

5-5. MANUFACTURERS' CROSS REFERENCE LIST COLUMN DESCRIPTIONS

a. The six-digit part number, by which the item is identified at the John Fluke Mfg. Co., Inc. is listed in the FLUKE STOCK NO. column. Use this number when ordering parts from the factory or authorized representatives.

b. The Federal Supply Code for the item manufacturer is listed in the MFG column. An abbreviated list of Federal Supply Codes is included in Appendix A.

c. The part number which uniquely identifies the item to the original manufacturer is listed in the MFG PART NO. column. If a component must be ordered by description, the type number is listed.

5-6. HOW TO OBTAIN PARTS

5-7. Standard components have been used whenever possible. Standard components may be ordered directly from the manufacturer by using the manufacturer's part number, or parts may be ordered from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE stock number. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-8. You can insure prompt and efficient handling of your order to the John Fluke Mfg. Co., Inc. if you include the following information.

a. Quantity.

b. FLUKE Stock Number.

c. Description.

d. Reference Designation.

e. Instrument model and serial number.

Example: 2 each, 215897, Transistor, 2N4136 A2A1Q1 & Q2 for 645A, S/N 123.

If you must order structural parts not listed in the parts list, describe the part as completely as possible. A sketch of the part, showing its location relative to other parts of the instrument is helpful.

5-9. SERIAL NUMBER EFFECTIVITY

5-10. This manual provides parts lists and schematics describing the most up-to-date configuration for the basic instrument and options as of the current manual revision date.

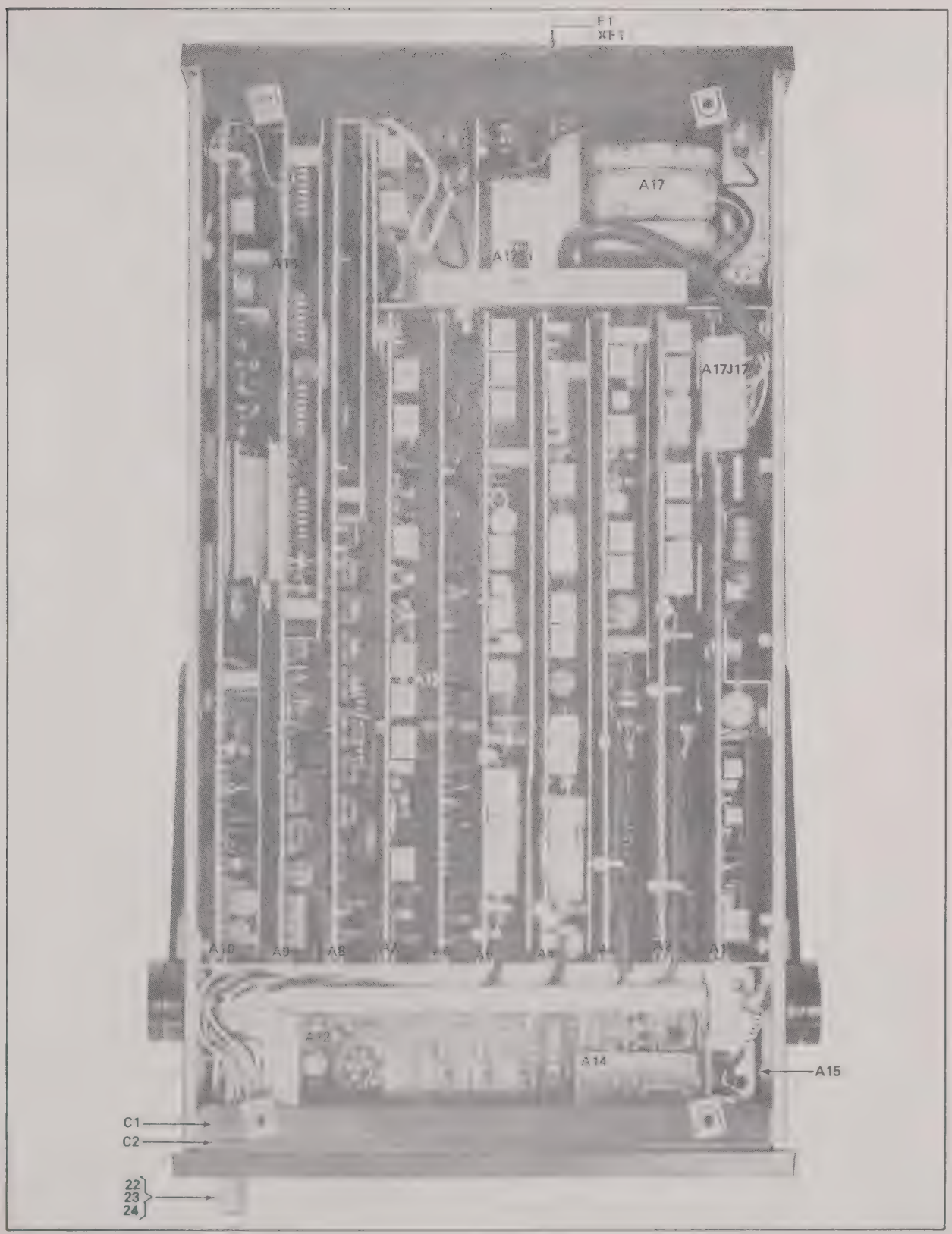


Figure 5-1. DIGITAL VOLTMETER

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	DIGITAL VOLTMETER Figure 5-1	8200A			
A1	Power Supply Figure 5-2	290189	1	1	
A2	Ohms Converter (–03 Option) Figure 5-3	290619	1	1	
A3	Millivolt Converter (–02 Option) Figure 5-4	290627	1	1	
A4	Input Buffer Figure 5-5	290635	1	1	
A5	AC Converter (–01 Option) Figure 5-6	290643	1	1	
A6	Logic Control Figure 5-8	290577	1	1	
A7	A/D Analog Figure 5-9	290197	1	1	
A8	Remote Control (–08 Option) Figure 5-10	290668	1	1	
A9	Data Output Unit No. 1 (–07 Option) Figure 5-11	290676	1	1	
A10	Data Output Unit No. II (–07 Option) Figure 5-12	290684	1	1	
A11	External Reference (–04 Option) Figure 5-13	290692	1	1	
A12	Display Assembly Figure 5-14	290379	1	1	
A13	Interconnect Assembly Figure 5-15	290700	1	1	
A14	Lamp Assembly (Upper) Figure 5-16	290718	1	1	
A15	Lamp Assembly (Lower) Figure 5-17	290726	1	1	
A16	Printer Output (–06 Option) Figure 5-18	290783	1	1	
A17	Transformer Assembly Power	292649	1	1	
A17J17	Conn, PCB edge, right angle	291567	1		
A17P20	Jack, teflon, ins	295287	2		
A17S1	Switch slide	226274	1	1	
A28	True RMS Converter (–09 Option)	339317	1		
C1	Cap, cer, 47 pf ±10%, 2kV/3.5kV	282145	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
C2	Cap, cer, 0.005 uf ±20%, 50v	175232	1		
F1	Fuse, fast acting, 1/2 amp	153858	1	5	
J22	Binding post, red, Hi	275552	1		
J23	Binding Post, black, Lo	275560	1		
J24	Binding Post, blue, Guard	275578	1		
XF1	Fuseholder	295030	1		
	Cable, pwr, Input, Main Frame	300202	1		
	Chassis	328526	2		
	Cord set	284174	1	1	
	Cover, bottom	298976	1		
	Cover assembly top, plstc.	311019	1		
	Foot bail stand	292870	1		
	Front Panel	291971	1		
	Front Panel, decal	292847	1		
	Guard Assy, bottom	308932	1		
	Guard front	290452	1		
	Guard assy, top	308924	1		
	Guard assy, rear	292284	1		
	Handle, frame, 1/2 RW	310045	1		
	Handle grip	284836	1		
	Knob, male half, black	309047	1		
	Knob, female half, black	309054	1		
	Shorting link	190728	1	3	
	Rear Panel assembly	321588	1		
P26	Conn, bulkhead, AC power receptacle	284166	1		
	OPTION KITS:				
	AC Converter (8200A-01k)	299818	1		
	AC Converter Assy	290643	REF		
	Millivolt Converter (8200A-02k)	299826	1		
	Millivolt Converter Assy	290627	REF		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	Ohms Converter (8200A-03k)	299834	1		
	Ohms Converter Assy	290619	REF		
	External Reference (8200A-04k)	299842	1		
	External Reference PCB	290692	REF		
	Parallel Rear Input (8200A-05k)	299404	1		
	Filter Assy. Rear	329144	1		
	Cable, option, input rear	300228	1		
J24	Conn, receptacle, 5 pin contact	295550	1		
	Input filter, choke	333161	1		
	Input filter, choke	333179	1		
	Conn, mating	321653	1		
	Conn, plug 5 pins	295543	1		
	Conn, pins	260976	5		
	Cable, clamp assy	295584	1		
	Printer Output (8200A-06k)	299867	1		
	Printer Output Assy	290783	REF		
	Conn, mating	321646	1		
	Conn, mating, backshell, half	292318	2		
	Conn, insert polarizing	295014	1		
	Conn, digital	308270	1		
	Data Output (8200A-07k)	299875	1		
	Data Output Assemblies	304071			
	Data Output No. I PCB	290676	REF		
	Data Output No. II PCB	290684	REF		
	Conn, mating	321646	2		
	Conn, mating, backshell half	292318	4		
	Conn, insert, polarizing	295014	2		
	Conn, digital	308270	2		
	RMS Converter (8200A-09k)		1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	RMS Converter, Electronic PCB	339317	REF		
	ACCESSORIES:				
	Offset Rack Mounting Kit	M03-203-601			
	Side-by-side Rack Mounting Kit	M03-200-603			
	PCB Extender Card	292029			
	Fan	315655			

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A1	POWER SUPPLY Figure 5-2	290189	REF		
C1	Cap, elect, 8 uf +50/−10%, 350v	288746	1		
C2, C4	Cap, elect, 400 uf +50/−10%, 25v	168153	2		
C3, C5	Cap, elect, 125 uf +50/−10%, 16v	186296	2		
C6 thru C11	Cap, elect, 1,000 uf, +50/−10%, 10v	289132	6		
C12	Cap, plstc, 0.047 uf ±10%	162008	1		
C13	Cap, cer, 0.01 uf ±20%, 100v	149153	1		
CR1 thru CR8, CR13 thru CR16	Diode, silicon, 1 amp, 600 piv	112383	4		
CR9	Diode, zener	289009	1		
CR10	Diode, silicon, 150mA	203323	1		
CR11, CR12	Not used				
Q1, Q2	Tstr, silicon, NPN	218511	2		
Q3, Q10, Q12	Tstr, silicon, NPN	150359	3		
Q4, Q5, Q13	Tstr, silicon, NPN	168708	3		
Q6, Q7	Tstr, silicon, PNP	195974	2		
Q8, Q9	Not used				
Q11	Tstr, silicon, NPN	170787	1		
R1	Res, comp, 510Ω ±5%, 1/2w	108951	1		
R2, R19	Res, comp, 33k ±5%, 1/4w	148155	2		
R3	Res, met flm, 182k ±1%, 1/8w	241091	1		
R4	Res, met flm, 15.4k ±1%, 1/8w	261651	1		
R5, R7	Res, comp, 1M ±5%, 1/4w	182204	2		
R6, R16	Res, comp, 33Ω ±10%, 1/2w	108456	2		
R8	Res, comp, 470k ±5%, 1/4w	188441	1		
R9, R21	Res, comp, 4.7k ±5%, 1/4w	148072	2		
R10	Res, comp, 5.1k ±5%, 1/4w	193342	1		
R11	Res, met flm, 7.87k ±1%, 1/8w	294934	1		

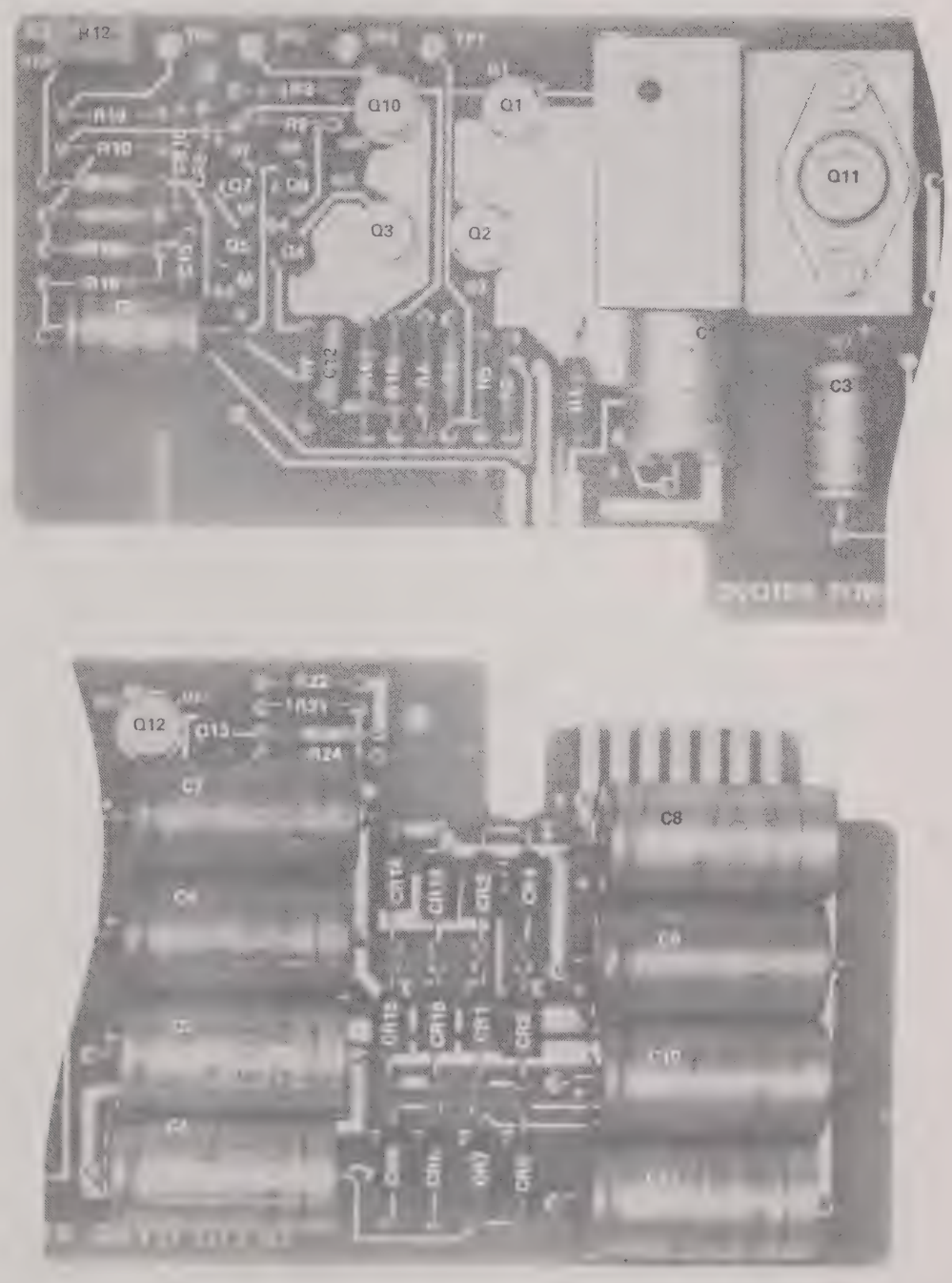


Figure 5-2. POWER SUPPLY

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R12	Res, var, cermet, 1k ±10%, 1/2w	285155	1		
R13	Res, met flm,5.9k ±1%, 1/8w	267351	1		
R14, R23	Res, met flm, 10k ±1%, 1/8w	168260	2		
R15, R17, R20	Not used				
R18	Res, met flm, 9.09k ±1%, 1/8w	221663	1		
R22	Res, comp, 5.6k ±5%, 1/4w	148080	1		
R24	Res, met flm, 33.2k ±1%, 1/8w	291393	1		
	Heat sink, Q11	305268	1		

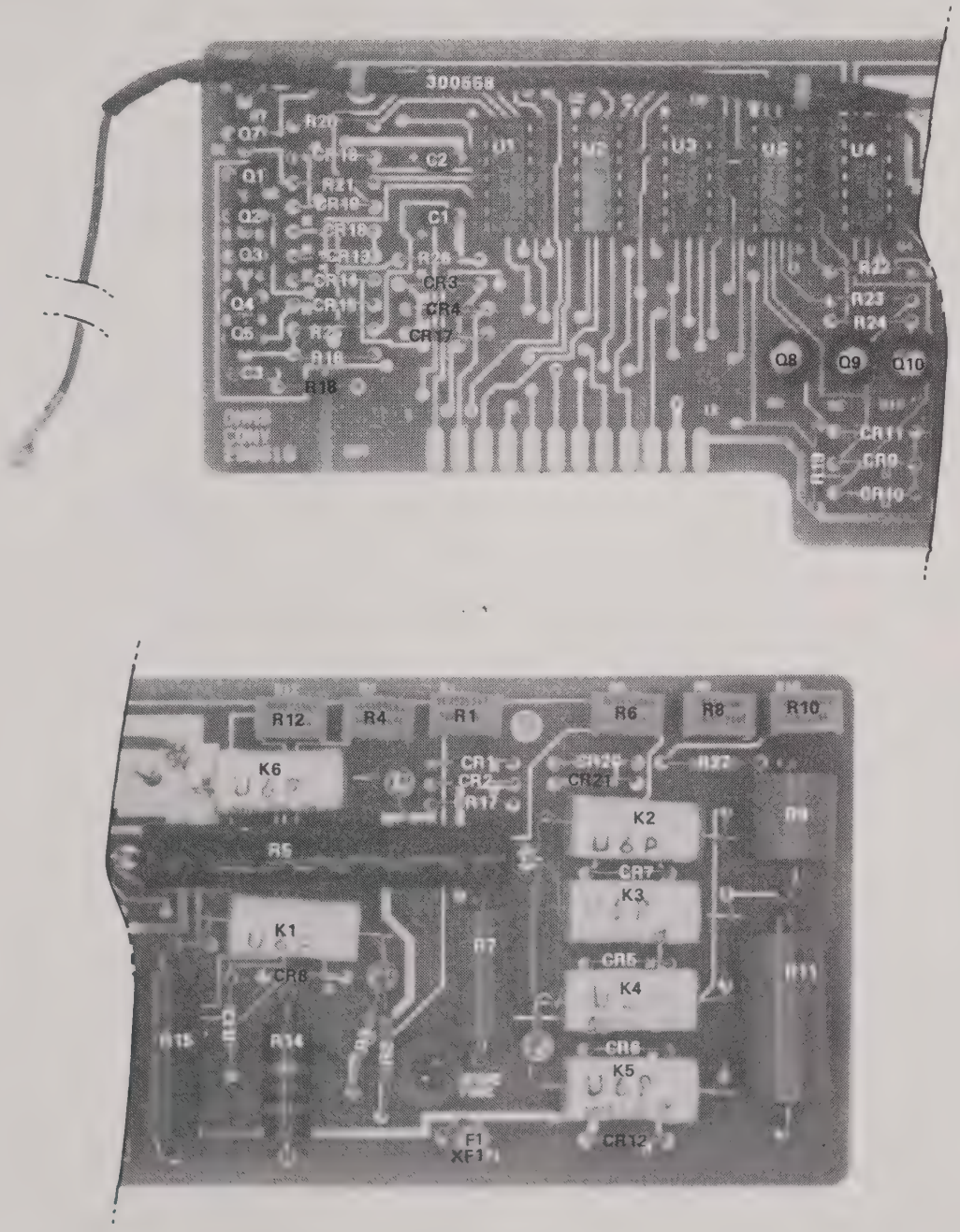


Figure 5-3. OHMS CONVERTER (–03 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A2	**OHMS CONVERTER (–03 Option)** Figure 5-3	290619	REF		
C1, C2	Cap, Ta, 0.22 uf ±20%, 35v	161331	2		
C3	Cap, cer, 0.005 uf ±20%, 50v	175232	1		
CR1, CR2	Diode, zener	276980	2		
CR3, CR4 CR9, CR10 CR11, CR13, CR14, CR15, CR17, CR18	Diode, germanium, 80 mA, 100 piv	149187	10		
CR5 thru CR8, CR12, CR16, CR19, CR20, CR21, CR22	Diode, silicon, 150mA	203323	10		
CR23	Diode, zener, uncomp, 4.3V	180455	1		
F1, F2	Fuse, pigtail, 125v	289967	2		
K1 thru K6	Coil, reed relay Switch, dry reed, miniature (use with K1 thru K5) Switch, dry reed, miniature (use with K6) Switch, reed, coil wrap (use with K6)	269019 289850 284091 313833	6 5 1 1		
Q1 thru Q7	Tstr, silicon, NPN	218396	7		
Q8, Q9, Q10	Tstr, selected	203364	3		
Q11	Tstr, silicon, NPN	218396	REF		
R1	Res, var, cermet, 25k ±10%, 1/2w	289678	1		
R2	Res, met flm, 900k ±0.1%, 1/4w	225755	1		
R3	Res, met flm, 102k ±0.1%, 1/8w	293522	1		
R4	Res, var, cermet, 500Ω ±10%,	291120	1		
R5	Res, met flm, 6.99M ±0.1%, 2w	284968	1		
R6	Res, var, cermet, 1k ±10%, 1/2w	285155	1		
R7	Res, ww, 777.15k ±0.05%, 3/4w	277913	1		
R8	Res, var, cermet, 100Ω ±10%, 1/2w	285130	1		
R9	Res, ww, 70.02k ±5%, 1/2w	290932	1		
R10,R12	Res, var cermet, 10k ±10%, 1/2w	285171	2		
R11	Res, ww, 8.125k ±0.05%, 1w	290940	1		
R13	Res, met flm, 44.2k ±1%, 1/8w	271676	1		
R14	Res, comp, 560Ω ±5%, 2w	218818	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R15	Res, ww, 708, 2Ω ±0.05%, 1w	290957	1		
R16	Res, comp, 1.8k ±5%, ¼w	175042	1		
R17	Res, comp, 47k ±5%, ¼w	148163	1		
R18, R25	Res, comp, 1.2k ±5%, ¼w	190371	2		
R19, R24	Res, comp, 270Ω ±5%, ¼w	160804	4		
R20, R21	Res, comp, 270Ω ±5%, ¼w	148106	2		
R22, R23	Res, comp, 270Ω ±5%, ¼w	160804	REF		
R26	Res, comp, 2.2k ±5%, ¼w	148049	1		
R27	Res, met flm, 178k ±1%, 1/8w	234989	1		
R28	Res, comp, 220Ω ±5%, ¼w	147959	1		
R29	Res, comp, 100Ω ±5%, ¼w	147926	1		
U1	IC, DTL, Quad, 4-Input, Nand	268383	1		
U2	IC, DTL, Quad, 2-Input, Nand	268375	1		
U3, U5	IC, DTL, Triple, 3-Input, Nand Gate	266312	2		
U4	IC, DTL, Quad, 2-Input, Nand Pwr Gate	288597	1		
XF1	Fuseholder, miniature	296582	1		
	Cable, ohms converter, input	300558	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A3	**MILLIVOLT CONVERTER (–02 Option)** Figure 5-4	290627	REF		
C1	Cap, plstc, 0.68 uf ±10%, 50v	284695	1		
C2	Cap, plstc, 0.33 uf ±10%, 50v	284703	1		
C3	Cap, plstc, 0.001 uf	159582	1		
C4, C5	Cap, cer, 0.05 uf ±20%, 100v	149161	2		
C6, C7	Cap, mica, 100 pf ±5%, 500v	148494	2		
C8	Cap, mica, 33 pf ±5%, 500v	160317	1		
C9	Cap, plstc, 0.01 uf ±10%, 50v	309906	1		
C10	Cap, plstc, 1.0 uf ±10%, 50v	271619	1		
C11	Cap, plstc, 0.082 uf ±10%, 50v	309914	1		
C12	Cap, Ta, 15 uf, ±20%, 6V	161935	1		
C13, C14	Cap, plstc, 0.1 uf ±10%, 250v	161992	2		
CR1 thru CR4	Diode, silicon, 10 ma, 2 piv	180554	4		
CR5, CR6, CR10	Diode, germanium, 80 ma, 100 piv	149187	3		
CR7, CR8, CR9, CR11, CR12, CR13, CR14	Diode, silicon, 150 ma	203323	7		
K1	Relay, 4 PDT, 5v coil	272716	1		
K2	Coil, relay Relay, reed switch (use with K2)	288613 289850	1 5		
K3, K4	Coil relay Relay reed switch (use with K3, K4)	269019 289850	2 REF		
Q1, Q6	Tstr, silicon PNP	195974	2		
Q2	Tstr, germanium, PNP	148643	1		
Q3	Tstr, silicon, NPN, Super beta, dual monolithic	284075	1		
Q4	Tstr, silicon, NPN	168716	1		
Q5, Q7, Q8, Q9,	Tstr, silicon, NPN	218396	4		
Q10	Tstr, silicon, PNP, selected	280198	1		

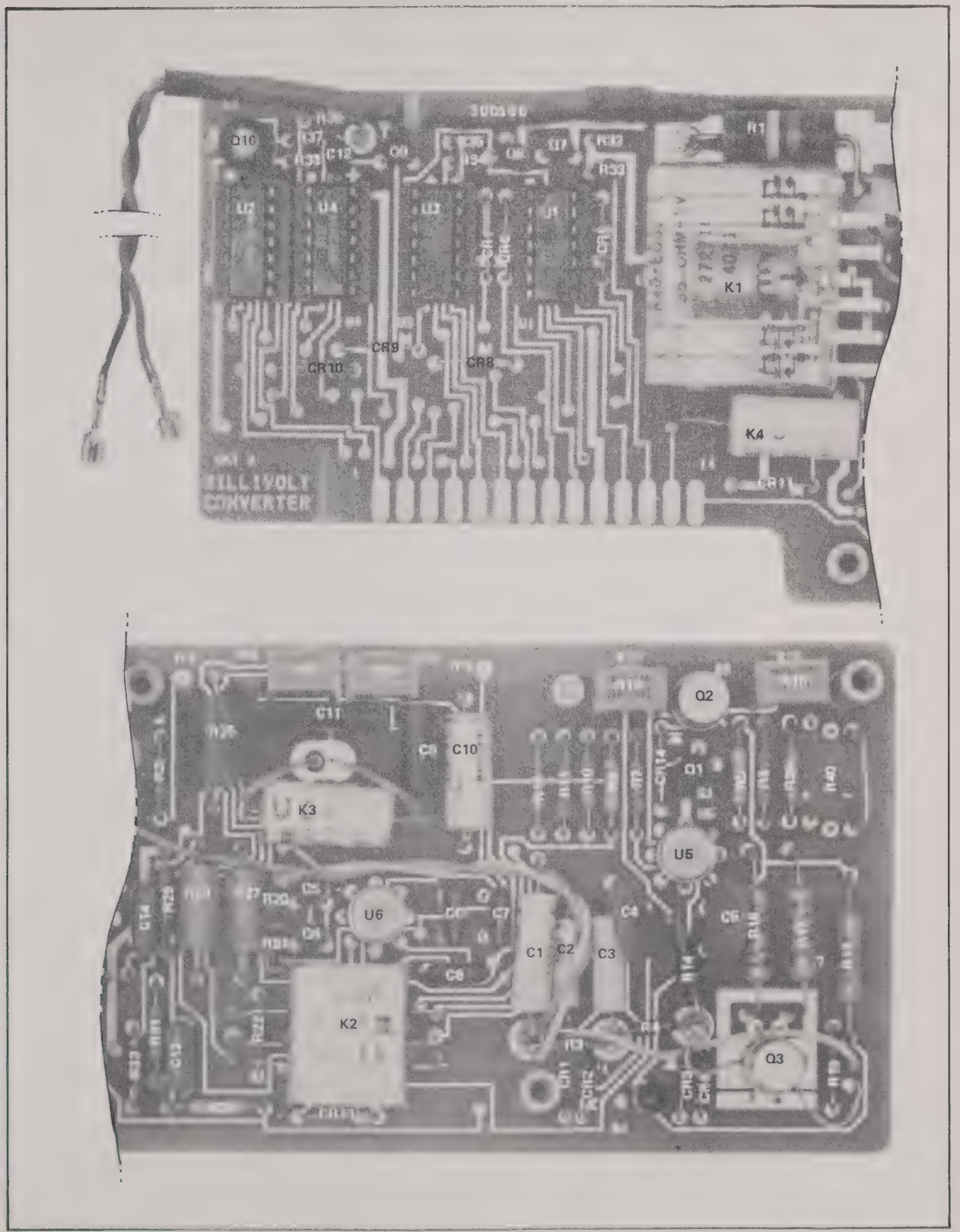


Figure 5-4. MILLIVOLT CONVERTER (–02 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R1	Res, comp, 100k ±5%, 2w	285056	1		
R2	Res, comp, 4.7k ±5%, 1/4w	148072	1		
R3	Res, comp, 120k ±5%, 1/4w	193458	1		
R4, R19, R34, R35	Res, comp, 10k ±5%, 1/4w	148106	4		
R5	Res, met flm, 49.9k ±1%, 1/8w	268821	1		
R6	Res, met flm, 82.5k ±1%, 1/8w	246223	1		
R7	Res, met flm, 154k ±1%, 1/8w	289447	1		
R8	Res, met flm, 7.5k ±1%, 1/8w	223529	1		
R9	Not used				
R10	Res, met flm, 2.32k ±1%, 1/8w	260315	1		
R11	Res, met flm, 232Ω ±1%, 1/8w	289975	1		
R12	Res, met flm, 73.2k ±1%, 1/8w	237222	1		
R13	Res, var, cermet, 25k	289678	1		
R14	Res, comp, 100M ±10%, 1/2w	190520	1		
R15	Res, var, cermet, 10k ±10%, 1w	285171	1		
R16, R17	Res, met flm, 2M, Matched Set	290320	1		
R18	Res, met flm, 2.43M ±1%, 1/2w	283705	1		
R20, R21, R36,	Res, comp, 1.8k ±5%, 1/4w	175042	3		
R22	Res, comp, 1k ±5%, 1/4w	148023	1		
R23	Res, comp, 200Ω ±5%, 1/4w	193482	1		
R24	Res, var, cermet, 500Ω ±10%, 1w	291120	1		
R25	Res, ww, 90k ±0.05%, 1/2w	277855	1		
R26	Res, var, cermet, 50Ω ±10%, 1w	285122	1		
R27	Res, ww, 9k ±0.03%, 1/4w	256990	1		
R28	Res, ww, 1k ±0.05%, 1/4w	163931	1		
R29	Res, comp, 2.2Ω ±5%, 1/2w	267666	1		
R30	Res, met flm, 1M ±1%, 1/8w	268797	1		
R31	Res, met flm, 332k	289504	1		
R32, R33	Res, comp, 2.2k ±5%, 1/4w	148049	2		
R37	Res, comp, 220Ω ±5%, 1/4w	147959	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R38	Res, comp, 180Ω ±5%, 1/4w	147942	1		
R39, R40	Res, met flm, factory selected value, may not be installed	1			
U1	IC, DTL, Triple 3-Input Nand Gate	266312	1		
U2	IC, DTL, Quad 2-Input Nand Gate	268375	1		
U3	IC, DTL, Dual 4-Input Nand	268383	1		
U4	IC, DTL, Quad 2-Input Nand Power Gate	288597	1		
U5	IC, voltage follower	288365	1		
U6	IC, operational amplifier	284760	1		
	Cable, Input, MV converter	300566	1		

1 R39 and R40 are factory selected for replacement order exact value.

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A4	**INPUT BUFFER** **Figure 5-5**	290635	REF		
C1	Cap, plstc, 0.013 uf ±5%, 100v	284893	1		
C2	Not used				
C3	Cap, plstc, 0.056 uf ±5%, 100V	284877	1		
C4	Cap, plstc, 0.033 uf ±5%, 80v	283580	1		
C5	Cap, plstc, 0.0082 uf ±5%, 100v	284901	1		
C6	Cap, cer, 15 pf ±10%, 500v	330118	1		
C7	Cap, plstc, 0.047 uf ±10%	162008	1		
C8, C11	Cap, mica, 390 pf ±5%, 500v	148437	2		
C9	Cap, mica 36 pf ±5%, 500v	148628	1		
CR1, CR2, CR25, CR26	Diode, Si, 10 mA, 2 piv	180554	4		
CR3 thru CR8, CR20 thru CR24	Diode, Si, 150 mA, 100 piv	203323	11		
CR9, CR10, CR11	Diode, Ge, 80 mA, 100 piv	149187	3		
CR13 thru CR19	Diode, Si, 75 mA, 100 piv	203323	7		
DS1	Lamp, neon	162776	1		
K1, K2	Coil, reed relay Switch, reed relay	313270 277020	2 2		
K3, K4, K5, K9	Coil, reed relay	269019	4		
	Switch, reed relay (K9) Switch, dry reed (K3, K4, K5) Switch, dry reed, foil wrap (K3, K4, K5, K9)	289850 309658 313833	5 3 7		
K6, K7, K8	Coil, reed relay Switch, reed relay (K6, K7, K8) Switch, reed, foil wrap (K6, K7) Switch, reed (K6, K7)	272070 289850 313833 198267	3 REF REF 2		
Q1, Q3, Q5, Q6, Q8	Xstr, Si, NPN	218396	5		
Q2, Q7	Xstr, Si, PNP	195974	2		
Q4	Xstr, Si, PNP	280198	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R1, R2, R4, R6, R8	Res, 4.0975M ±0.2% Res, 898.9k ±0.03% Res, 89.89k ±0.03% Res, 9.99k ±0.03% Matched Set	1			
R3	Res, var, cermet 2k ±10%, 1/2w	285163	1		
R5	Res, var, cermet, 200Ω ±10%, 1/2w	285148	1		
R7	Res, var, cermet, 20Ω ±10%, 1/2w	285114	1		
R9	Res, met flm, 100k ±1%, 1/8w	248807	1		
R10	Res, met flm, 806k ±1%, 1/8w	217976	1		
R11 thru R14	Res, met flm,909k±1%, 1/8w	288548	4		
R15	Res, comp, 200Ω ±5%, 1/4w	193482	1		
R16, R17	Res, met flm, buffered, matched set	334615	1		
R18	Res, met flm, 35.7k ±1%, 1/8w	288480	1		
R19	Res, comp, 1.8M ±5%, 1/4w	289629	1		
R20	Res, met flm, 402Ω ±1%, 1/8w	289611	1		
R21	Res, met flm, 1M ±1%, 1/8w	268797	1		
R22	Res, var, cermet, 500k ±20%, 1/2w	288753	1		
R23, R28, R31, R32	Res, comp, 1k ±5%, 1/4w	148023	4		
R24	Res, comp, 15k ±5%, 1/4w	148114	1		
R25, R38	Res, comp, 180Ω ±5%, 1/4w	147942	2		
R26	Res, comp, 1.8k ±5%, 1/4w	175042	1		
R27	Res, comp, 10k ±5%, 1/4w	148106	1		
R29, R33	Res, comp, 6.8k ±5%, 1/4w	148098	2		
R30, R34	Res, comp, 68k ±5%, 1/4w	148171	2		
R35, R36	Res, met flm, 402k ±0.1%, 1/2w	272781	2		
R37	Res, comp, 22Ω ±5%, 1/4w	147884	1		
R39	Res, comp, 470Ω ±5%, 1/4w	147983	1		
U1	IC, operational amplifier	277392	1		
U2	Tstr, FET, dual, N-channel, selected	292490	1		
U3	IC, operational amplifier	271502	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
U4	IC, DTL, Quad, 2-Input Nand Power Gate	288597	1		
	Cable, Buffer Attenuator, Input	301796	1		
	1 R1, R2, R4, R6 and R8 are a matched set. For replacement order Input Divider Set P/N 285312.				

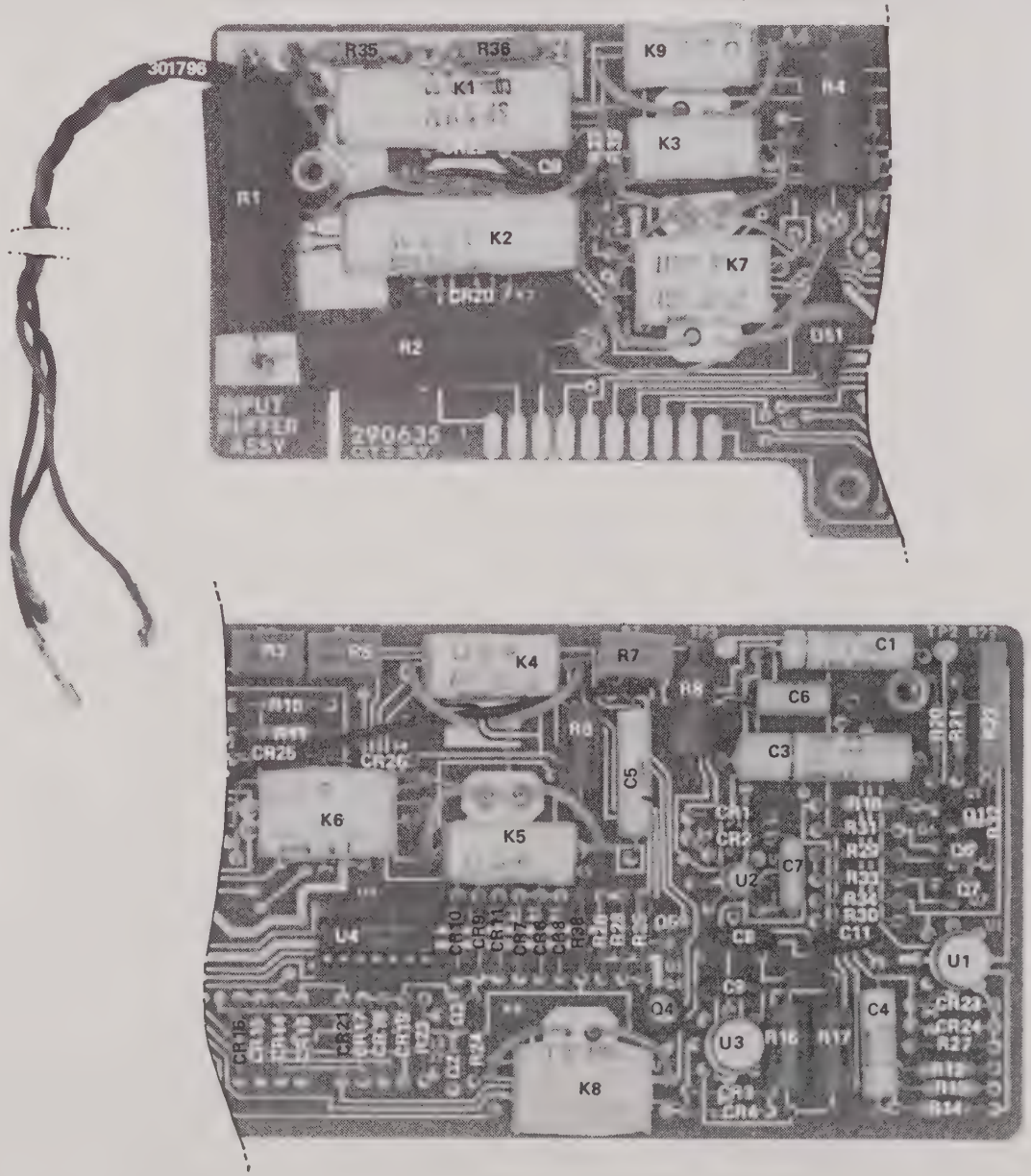


Figure 5-5. INPUT BUFFER

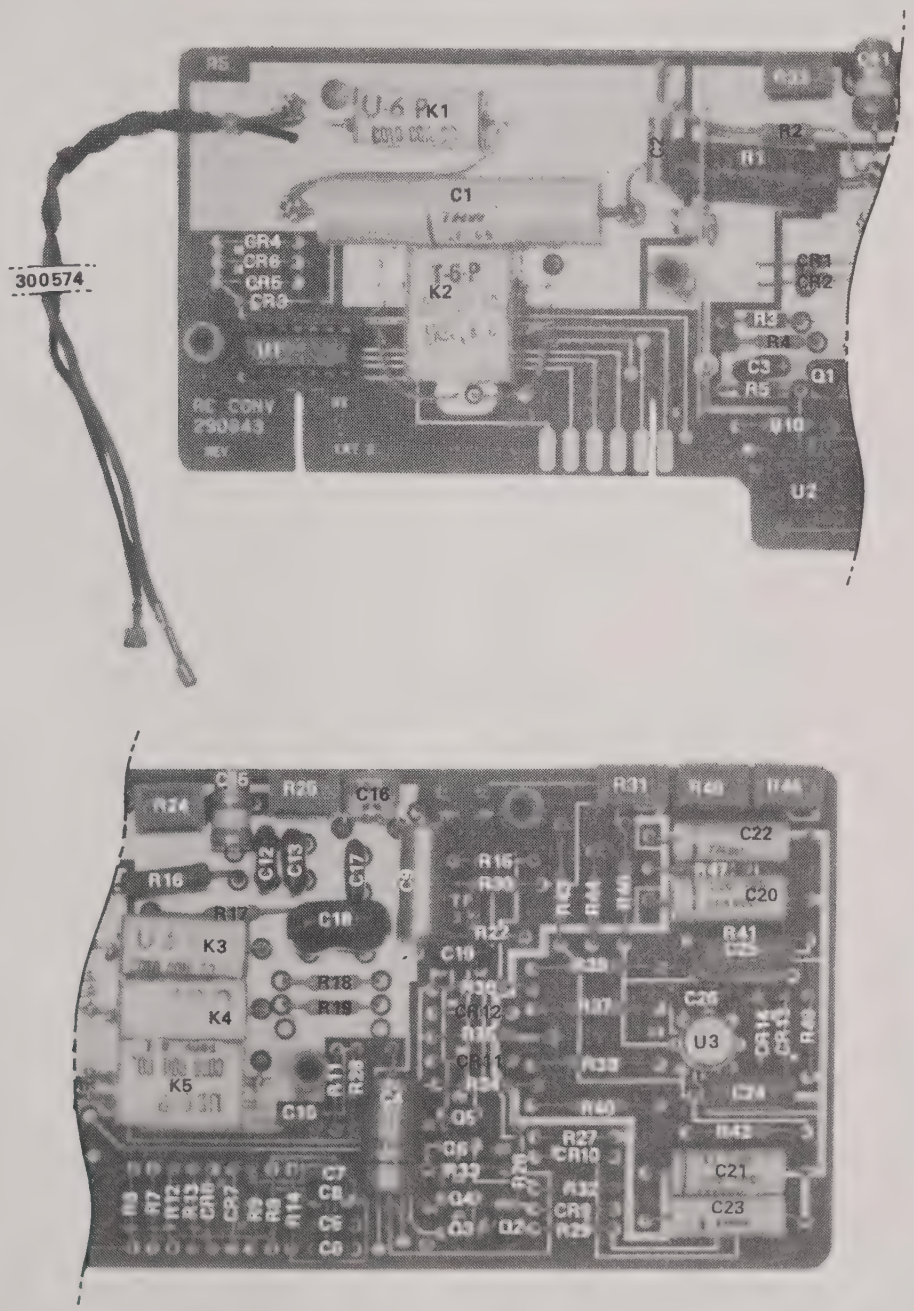


Figure 5-6. AC CONVERTER (–01 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A5	**AC CONVERTER (–01 Option)** Figure 5-6	290643	REF		
C1	Cap, plstc, 0.22 uf ±20%, 1200v	268904	1		
C2	Cap, var, teflon, 0.25 to 1.5 pf, 2kv	273151	1		
C3, C8	Cap, Ta, 4.7 uf ±20%, 20v	161943	2		
C4	Cap, elect. 125 uf +50/–10%, 16v	186296	1		
C5, C6	Cap, cer, 500 pf ±10%, 1kv/2250	105692	2		
C7, C10	Cap, cer, 0.01 uf ±20%, 100v	149153	2		
C9	Cap, Ta, 100 uf ±10%, 10v	170456	1		
C11, C15	Cap, var, air, 0.8-10 pf, 250v	229930	2		
C12	Cap, mica, 12 pf ±5%, 500v	175224	1		
C13	Cap, mica, 150 pf ±1%, 500v	226134	1		
C14	Not used				
C16	Cap, var, cer, 9-35 pf, 350v	289637	1		
C17	Cap, mica, 56 pf +1%, 500v	284810	1		
C18	Cap, mica, 4700 pf ±5%, 500v	208975	1		
C19	Cap, mica, 68 pf ±5%, 500v	148510	1		
C20, C21	Cap, plstc, 0.47 uf, Matched pair	288233	1		
C22, C23	Cap, plstc, 1 uf, Matched pair	288225	1		
C24, C25	Cap, plstc, 0.22 uf ±10%, 250v	194803	2		
C26	Cap, mica, 33 pf ±5%, 500v	160317	1		
CR1, CR2, CR7, CR8	Diode, silicon, 20 piv, 10 mA	376907	6		
CR3 thru CR6, CR13, CR14	Diode, silicon, 150 ma	203323	6		
CR9, CR10	Diode, zener, 4.3v	180455	2		
CR11, CR12	Diode, silicon, 20 piv, 10 mA	375907	REF		
K1, K3, K4	Coil, relay Relay, reed switch (use with K1) Reed switch, foil wrap (use with K1) Reed switch, foil wrap (use with K3, K4, K5)	269019 284019 313838 280008	3 1 1 4		
K2	Coil, relay Relay, reed switch (use with K2, K3, K4, K5)	288613 289850	1 7		
K5	Coil, relay	272070	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
Q1	Tstr, J-FET N-channel	271924	1		
Q2	Tstr, silicon, PNP	215897	1		
Q3, Q4, Q6	Tstr, silicon, PNP	229898	3		
Q5	Tstr, silicon, NPN	218081	1		
R1	Res, met flm, 1.11M } Matched Set	269092	1		
R16	Res, met flm, 267k }				
R2	Res, met flm, 100k ±1%, 1/8w	248807	1		
R3	Res, comp, 8.2k ±5%, 1/4w	160796	1		
R4	Res, met flm, 806Ω ±1%, 1/8w	223552	1		
R5, R8, R9, R22	Res, comp, 10k ±5%, 1/4w	148106	4		
R6, R12	Res, comp, 91k ±5%, 1/4w	193300	2		
R7, R13	Res, comp, 47Ω ±5%, 1/4w	147892	2		
R10	Res, met flm, 82.5k ±1%, 1/8w	246223	1		
R11, R26, R27	Res, comp, 20k ±5%, 1/4w	221614	3		
R14	Res, comp, 15k ±5%, 1/4w	148114	1		
R15	Res, comp, 4.7k ±5%, 1/4w	148072	1		
R17	Res, met flm, 29.53k ±0.1%, 1/8w	321471	1		
R18	Res, met flm, 2573Ω ±0.1%, 1/8w	321463	1		
R19	Res, met flm, 143.3Ω ±0.1%, 1/8w	321448	1		
R20, R21	Not used				
R23, R46	Res, var, cermet, 2k ±10%, 1w	285163	2		
R24, R31	Res, var, cermet, 200Ω ±10%, 1w	285148	2		
R25	Res, var, cermet, 20Ω ±20%, 1w	285114	1		
R28	Res, comp, 2.4k ±5%, 1/4w	193433	1		
R29	Res, met flm, 182Ω ±1%, 1/8w	289579	1		
R30	Res, met flm, 274Ω ±1%, 1/8w	235259	1		
R32	Res, comp, 22k ±5%, 1/4w	148130	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R33	Res, comp, 2.2k ±5%, 1/4w	148049	1		
R34, R36	Res, met flm, 1123Ω ±0.1%, 1/8w	321455	2		
R35	Res, met flm, 125Ω ±0.1%, 1/8w	321430	1		
R37 thru R40	Res, met flm, 130k ±0.1%, 1/8w	321497	4		
R41, R42	Res, met flm, 40k ±0.1%, 1/8w	321489	2		
R43, R45	Res, met flm, 151.5k ±0.1%, 1/8w	321505	2		
R44	Res, met flm, 332Ω ±1%, 1/8w	192898	1		
R47	Res, met flm, 1M, ±1%, 1/8w	268797	1		
R48	Res, var, cermet, 100k ±10%, 1/2w	288308	1		
R49	Res, comp, 220Ω ±5%, 1/4w	147959	1		
U1	IC, DTL, Quad 2-Input Nand Power Gate	288597	1		
U2	IC, 5-transistor array	248906	1		
U3	IC, operational amplifier	225961	1		
	Cable, Input AC Converter	300574	1		
	Socket, 14 pin contact	291542	1		

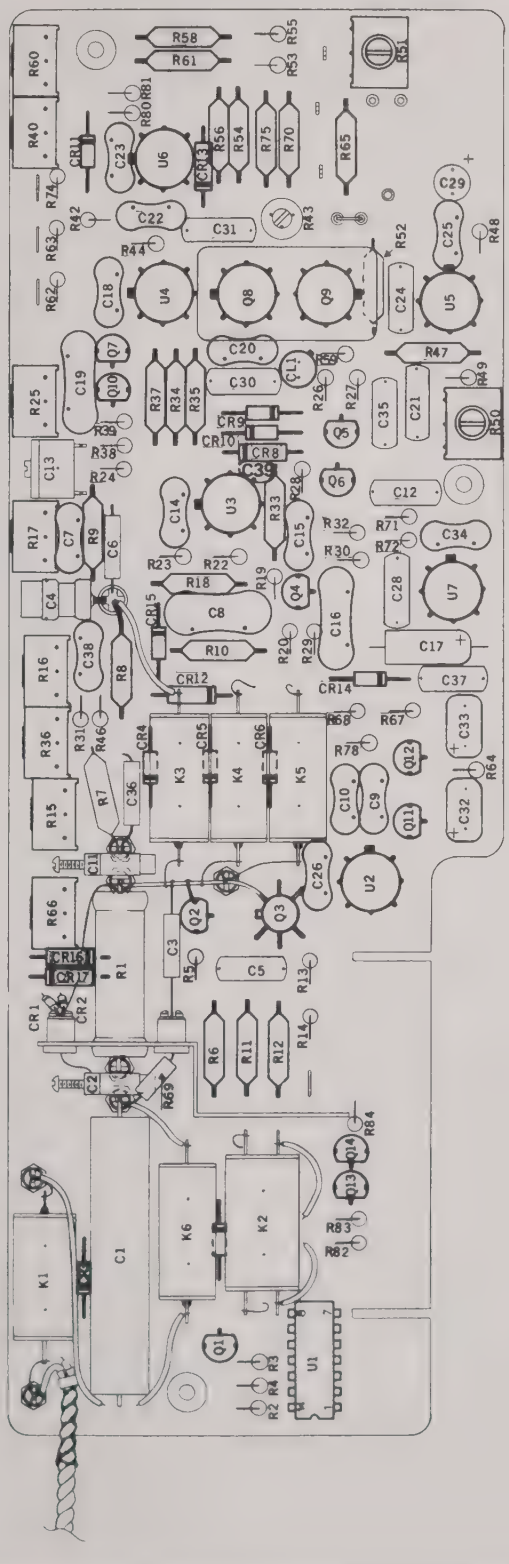


Figure 5-7. RMS CONVERTER (–09 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A28	RMS CONVERTER (–09 Option) Figure 6-5	339317	1		
C1	Cap, plstc, 0.22μf ±20%, 1200v	268904	1		
C2,C11	Cap, var, teflon, 0.25 to 1.5pf, 2kv	218206	2		
C3	Cap, porc, 2.7pf, 500v	340745	1		
C4	Cap, var, 10 to 12.5pf, 250v	229930	1		
C5,C12,C39	Cap, plstc, 0.1μf ±10%, 250v	161992	2		
C6	Cap, porc, 27pf ±5%, 500v	344283	1		
C7	Cap, mica, 330pf ±1%, 500v	226142	1		
C8	Cap, mica, 360pf ±2%, 500v	176644	1		
C9	Cap, mica, 22pf ±5%, 500v	148551	1		
C10	Cap, mica, 8pf ±10%, 500v	216986	1		
C13	Cap, var, cer, 9 to 35pf, 350v	289637	1		
C14,C18	Cap, mica, 27pf ±5%, 500v	177998	2		
C15	Cap, mica, 15pf ±5%, 500v	148569	1		
C16,C19	Cap, mica, 1000pf ±5%, 500v	148387	2		
C17	Cap, Ta, 22μf ±10%, 15v	182816	1		
C20,C26	Cap, mica, 2pf ±0.5pf, 500v	175208	2		
C21,C30 C31,C35, C37	Cap, plstc, 0.047μf ±10%, 250v	162008	5		
C22	Cap, mica, 390pf ±5%, 500v	148437	1		
C23,C25, C34	Cap, mica, 33pf ±5%, 500v	160317	3		
C24	Cap, mica, 0.082μf ±10%, 500v	342519	1		
C27	Not used				
C28	Cap, plstc, 0.033μf ±10%, 250v	234492	1		
C29	Cap, Ta, 4.7μf ±20%, 20v	161943	1		
C32,C33	Cap, Ta, 10μf ±20%, 15v	193623	2		
C36	Cap, porc, 2.2pf, 500v	340273	1		
C38	Cap, mica, 220pf ±5%, 500v	170423	1		
CL1	Diode, FET	285106	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
CR1,CR2, CR15	Diode, Si, Low cap	375907	5		
CR3 thru CR6,CR11, CR14,CR18	Diode, Si, 150 mA	203323	7		
CR7	Not used				
CR8,CR12	Diode, Zener	246611	2		
CR9,CR10	Diode, Si, Low cap	375907	REF		
CR13	Diode, Si, 10 mA, 2 piv	180554	1		
CR16,CR17	Diode, Zener	260695	2		
K1, K3, K4,K5,K6	Coil, reed relay Switch, reed, foil wrap (use with K1,K6) Switch, dry reed (used with K1,K6) Switch, reed, foil wrap (use with K3,K4,K5)	269019 313833 284091 280008	5 2 2 3		
K2	Coil, reed relay Switch, dry reed (use with K2A,K2B,K3,K4,K5)	272070 289850	1 5		
Q1,Q5,Q6	Xstr, Si, NPN	218396	3		
Q2,Q7	Xstr, FET	343103	2		
Q3	Xstr, FET, dual, N-channel	267963	1		
Q4,Q11, Q14	Xstr, J-FET, N-channel	288324	3		
Q8,Q9	Part of matched set, see 1	-----	1		
Q10,Q12, Q13	Xstr, Si, PNP	195974	3		
R1	Res, met flm, 1M ±0.1%, 1w	340265	1		
R2,R3,R4, R20,R84	Res, comp, 51k ±5%, ¼w	193334	5		
R5,R69	Res, comp, 12k ±5%, ¼w	159731	2		
R6	Res, met flm, 40.2k ±1%, 1/8w	235333	1		
R7	Res, met flm, 995k ±0.1%, ¼w	340158	1		
R8	Res, met flm, 110.6k ±0.1%, 1/8w	340224	1		
R9	Res, met flm, 10.05k ±0.1%, 1/8w	340216	1		
R10	Res, met flm, 1.001k ±0.1%, 1/8w	340208	1		
R11,R12, R35	Res, met flm, 50k ±0.1%, 1/8w	340257	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R13	Res, comp, 470Ω ±5%, ¼w	147983	1		
R14,R39, R49,R53, R68,R72	Res, comp, 1M ±5%, ¼w	182204	6		
R15	Res, var, cermet, 10k ±10%, ½w	285171	1		
R16	Res, var, cermet, 1k ±10%, ½w	285155	1		
R17,R60	Res, var, cermet, 100Ω ±10%, ½w	285130	2		
R18	Res, met flm, 4.975k ±0.1%, 1/8w	340232	1		
R19	Res, comp, 5.1k ±5%, ¼w	193342	1		
R21,R41	Not used				
R22	Res, comp, 3.9k ±5%, ¼w	148064	1		
R23,R63	Res, met flm, 100Ω ±1%, 1/8w	168195	2		
R24	Res, met flm, 845k ±1%, 1/8w	340851	1		
R25,R40, R66	Res, var, cermet, 1M ±10%, ½w	334722	3		
R26,R29, R42	Res, comp, 5.6k ±5%, ¼w	148080	3		
R27	Res, comp, 56k ±5%, ¼w	170738	1		
R28,R81	Res, comp, 1k ±5%, ¼w	148023	2		
R30	Res, comp, 9.1k ±5%, ¼w	193318	1		
R31	Res, comp, 100Ω ±5%, ¼w	147926	1		
R32,R80	Res, comp, 330Ω ±5%, ¼w	147967	2		
R33,R65	Res, met flm, 5k ±0.1%, 1/8w	340240	2		
R34	Res, met flm, 100k ±0.1%, 1/8w	340166	1		
R36	Res, var, comp, 50Ω ±20%, ½w	285122	1		
R37	Res, met flm, 35.7k ±1%, 1/8w	288480	1		
R38	Res, comp, 68Ω ±5%, ¼w	147918	1		
R43	Res, var, cermet, 3Ω ±25%, ½w	347963	1		
R44	Res, comp, 560Ω ±5%, ¼w	147991	1		
R46	Res, comp, 82k ±5%, ¼w	188458	1		
R47	Res, met flm, 1M ±1%, 1/8w	268797	1		
R48,R55	Res, comp, 510Ω ±5%, ¼w	218032	2		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R50,R51	Res, var, cermet, 1M ±10%, ½w	276691	2		
R52	Res, met flm, 1M ±0.25%, ¼w	340133	1		
R54	Res, met flm, 249k ±1%, 1/8w	268805	1		
R56	Res, met flm, 250k ±0.25%, 1/8w	340141	1		
R57	Not used				
R58	Res, met flm, 30.1Ω ±1%, 1/8w	296665	1		
R59	Res, comp, 18k ±5%, ¼w	148122	1		
R61	Res, met flm, 2k ±0.1%, 1/8w	340174	1		
R62	Res, met flm, 75Ω ±1%, 1/8w	306027	1		
R64	Res, comp, 13k ±5%, ¼w	221598	1		
R67	Res, met flm, 300k ±5%, ¼w	234682	1		
R70	Res, met flm, 3.035k ±1%, 1/8w	340182	1		
R71	Res, comp, 270k ±5%, ¼w	220061	1		
R73	Not used				
R74	Res, met flm, 200Ω ±1%, 1/8w	245340	1		
R75	Res, met flm, 10Ω ±1%, 1/8w	268789	1		
R45,R76, R77	Part of matched set, see 1	----	1		
R78,R82, R83	Res, comp, 22k ±5%, ¼w	148130	3		
U1	IC, DTL, Quad, 2-Input Nand Pwr Gate	288597	1		
U2	IC, Operational Amplifier	329912	1		
U3	IC, Operational Amplifier	225961	1		
U4	IC, Operational Amplifier	288928	1		
U5,U6	IC, Operational Amplifier	284760	2		
U7	IC, Operational Amplifier	271502	1		
	Cable, Input, AC Converter	300574	1		

1 Q8, Q9, R45, R76 and R77 form a factory matched set. If any of these components require replacement, total set must be replaced. Order "TC Matched set" part number 361030.

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A6	**LOGIC CONTROL** **Figure 5-8**	290577	REF		
C1	Cap, plstc, 0.01 uf ±2%, 100v	168385	1		
C2	Cap, mica, 1500 pf ±5%, 500v	148361	1		
C3	Cap, Ta, 1.0 uf ±20%, 50v	161919	1		
C4	Cap, cer 0.025 uf ±20%, 50v	168435	1		
C5	Cap, mica, 82 pf ±5%, 500v	148502	1		
C6	Cap, mica, 330 pf ±5%, 500v	148445	1		
C7	Cap, plstc, 0.22 uf ±10%, 250v	194803	1		
C8	Cap, mica, 15 pf ±5%, 500v	148569	1		
C9	Cap, mica, 270 pf ±5%, 500v	148452	1		
CR1, CR2	Tstr, unijunction,Si	268110	2		
CR3, CR5, CR6	Diode, Si, 150 mA	203323	3		
CR4	Diode, Ge, 80 mA, 100 piv	149187	1		
Q1 thru Q4	Tstr, silicon, NPN	218396	4		
Q5 thru Q16	Tstr, silicon, PNP	195974	12		
R1	Res, met flm, 140k ±0.5%, 1/8w	233148	1		
R2	Res, comp, 15k ±5%, 1/4w	148114	1		
R3	Res, met flm, 56.2k ±1%, 1/8w	271346	1		
R4	Res, met flm, 73.2k ±1%, 1/8w	237222	1		
R5, R29, R32, R35, R44	Res, comp, 2.2k ±5%, 1/4w	148049	5		
R6	Res, comp, 100Ω ±5%, 1/4w	147926	1		
R7	Res, comp, 2.7k ±5%, 1/4w	170720	1		
R8, R30, R33, R36, R39, R42, R45	Res, comp, 1.5k ±5%, 1/4w	148031	7		
R9	Res, comp, 820Ω ±5%, 1/4w	148015	1		
R10	Res, met flm, 750k ±1%, 1/2w	155192	1		
R11	Res, met flm, 110k ±1%, 1/8w	234708	1		
R12	Res, met flm, 46.4k ±1%, 1/8w	188375	1		

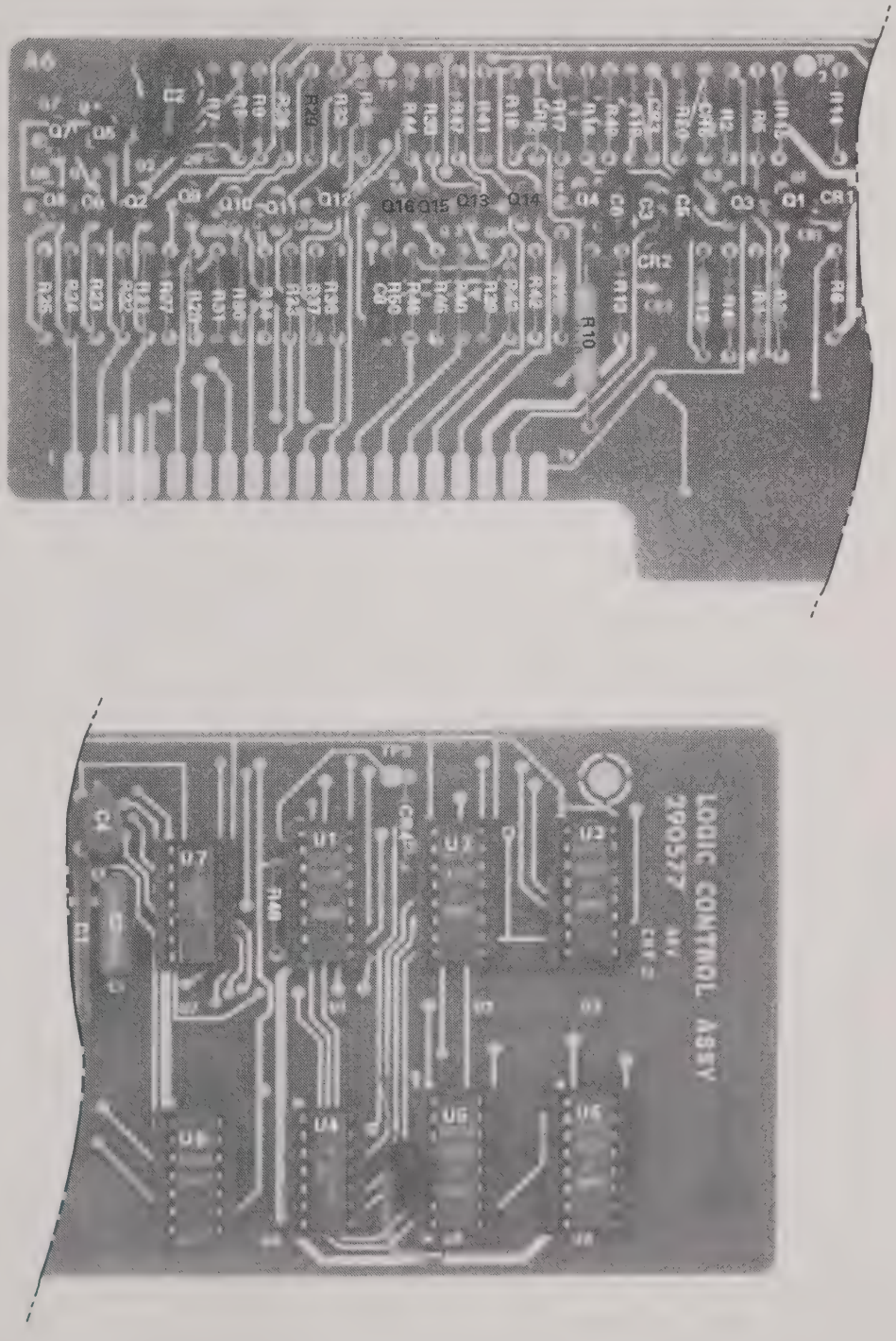
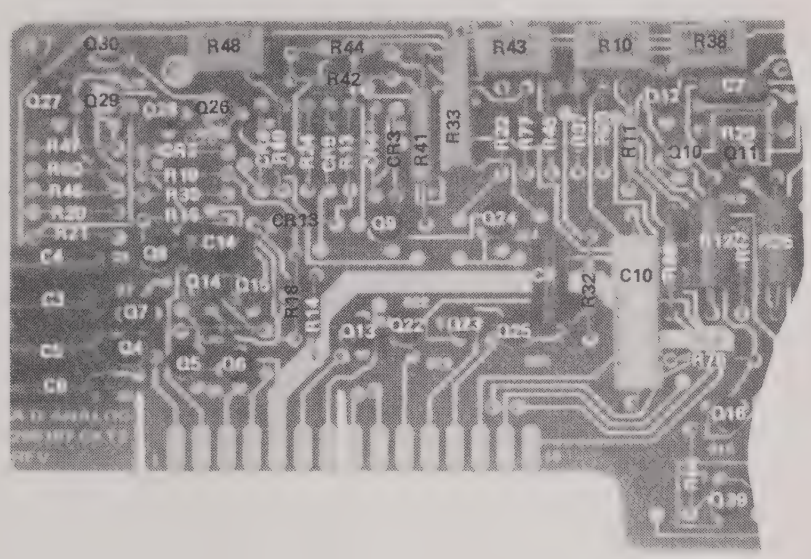


Figure 5-8. LOGIC CONTROL

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R13	Res, comp, 47Ω ±5%, 1/4w	147892	1		
R14, R18	Res, comp, 1k ±5%, 1/4w	148023	2		
R15	Res, comp, 3.9k ±5%, 1/4w	148064	1		
R16, R28, R50	Res, comp, 10k ±5%, 1/4w	148106	3		
R17	Res, comp, 27k ±5%, 1/4w	148148	1		
R19	Res, comp, 16k ±5%, 1/4w	221606	1		
R20	Res, comp, 3.3k ±5%, 1/4w	148056	1		
R21	Res, comp, 5.1k ±5%, 1/4w	193342	1		
R22 thru R25, R31, R34, R37, R40, R43, R46	Res, comp, 22k ±5%, 1/4w	148130	10		
R26	Res, comp, 4.7k ±5%, 1/4w	148072	1		
R27	Res, comp, 33k ±5%, 1/4w	148155	1		
R38, R41	Res, comp, 8.2k ±5%, 1/4w	160796	2		
R47	Res, comp, 470Ω ±5%, 1/4w	147983	1		
R48	Res, comp, 680Ω ±5%, 1/4w	148007	1		
R49	Res, comp, 1.2k ±5%, 1/4w	190371	1		
U1, U2, U3, U5, U6	IC, TTL, Dual J-K Flip-Flop	268441	5		
U4	IC, DTL, Dual 4-Input Nand	268383	1		
U7	IC, DTL, Quad 2-Input Nand Gate	268375	1		
U8	IC, TTL, Dual 4-Input Expandable Nor Gate	268557	1		
	Socket, IC, 14 contact	291542	3		
	Socket, IC, 16 contact	291534	5		



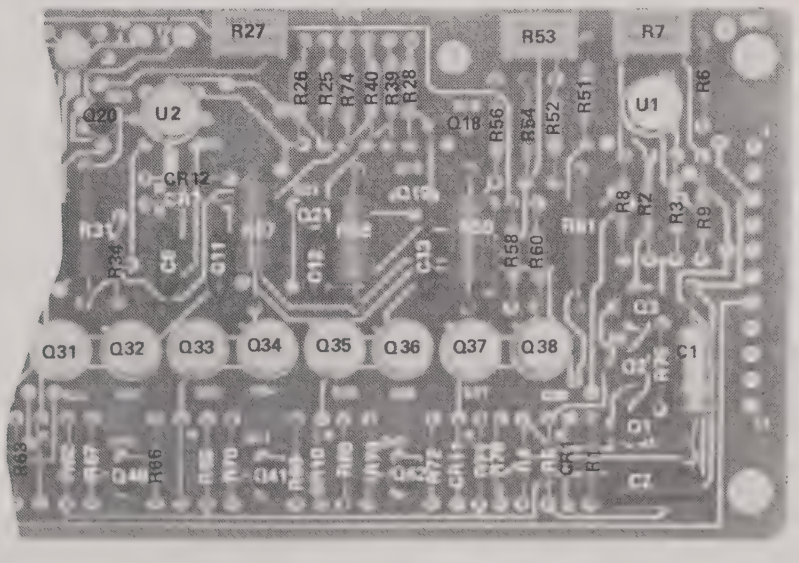


Figure 5-9. A/D ANALOG

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A7	**A/D ANALOG ASSEMBLY** Figure 5-9	290197	REF		
C1	Cap, elec, 1 uf +75/−10%	165886	1		
C2, C9	Cap, plstc, 0.022 uf ±10%, 50v	271577	2		
C3 thru C6	Cap, plstc, 0.0047 uf ±10%, 50v	260844	4		
C7	Cap, plstc, 0.1 uf ±10%, 250v	161992	1		
C8	Cap, mica, 33 pf ±5%, 500v	160317	1		
C10	Cap, plstc, 0.047 uf ±10%, 120v	260562	1		
C11	Cap, mica, 12 pf ±5%, 500v	175224	1		
C12	Cap, mica, 5 pf ±10%, 500v	148577	1		
C13	Cap, mica, 2 pf ±0.5 pf, 500v	175208	1		
C14	Cap, mica, 390 pf ±5%, 500v	148437	1		
CR1 thru CR13	Diode, Si, 150 mA	203323	13		
Q1, Q2, Q3 Q21, Q27, Q28	Xstr, Si, PNP	168708	6		
Q4 thru Q9, Q12, Q13, Q16, Q20, Q22 thru Q25	Xstr, J-FET, N-channel	288324	14		
Q10, Q11	Xstr, J-FET set	265744	1		
Q14, Q15, Q19	Xstr, Si, PNP	195974	3		
Q17	Not used				
Q18	Xstr, Si, NPN	218396	1		
Q26, Q29, Q30	Xstr, Si, PNP	288761	3		
Q31, Q33, Q35, Q37	Xstr, Ge, NPN	182691	4		
Q32, Q34, Q36, Q38	Xstr, Ge, PNP	182709	4		
Q39, Q40, Q41, Q42	Xstr, semicon, Si, NPN	159855	4		
R1	Res, comp, 68k ±5%, 1/4w	148171	1		
R2, R8, U1	Ref amp, set	1			

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R3	Res, met flm 2.94k ±1%, 1/8w	261628	1		
R4	Res, comp, 2.2k ±5%, 1/4w	148049	1		
R5	Res, comp, 36k ±5%, 1/4w	221929	1		
R6, R34	Res, comp, 3.3k ±5%, 1/4w	148056	2		
R7	Res, var, cermet, 100Ω ±10%, 1/2w	285130	2		
R9	Res, met flm, 13.3k ±1%, 1/8w	289603	1		
R10	Res, var, cermet, 10k ±10%, 1/2w	285171	1		
R11	Res, met flm, 107k ±1%, 1/8w	289165	1		
R12, R31, R35, R55, R57, R59, R61	Res, set, 7 pieces	2			
R13, R62	Res, comp, 12k ±5%, 1/4w	159731	2		
R14, R30	Res, comp, 2.2M ±5%, 1/4w	198390	2		
R15, R18, R19, R21	Res, comp, 20k ±5%, 1/4w	221614	4		
R16, R20, R24, R49	Res, comp, 1M ±5%, 1/4w	193458	4		
R17	Res, comp, 1k ±5%, 1/4w	148023	1		
R22, R23, R50	Res, comp, 220k ±5%, 1/4w	160937	3		
R25, R26	Res, met flm, 22.6k ±1%, 1/8w	288431	2		
R27	Res, var, cermet 100Ω ±10%, 1/2w	285130	REF		
R28	Res, met flm, 35.7k ±1%, 1/8w	288480	1		
R29	Res, comp, 150k ±5%, 1/4w	182212	1		
R32	Res, met flm, 57.6k ±1%, 1/8w	289116	1		
R33	Res, var, cermet, 10k ±20%, 1/2w	267880	1		
R36	Res, comp, 1Ω ±5%, 1/4w	218693	1		
R37	Res, comp, 33k ±5%, 1/4w	148155	1		
R38	Res, var, cermet, 50k ±10%, 1/2w	288290	1		
R39	Res, met flm, 4.42k ±1%, 1/8w	288514	1		
R40	Res, met flm, 10.5k ±1%, 1/8w	234096	1		
R41	Res, met flm, 1.82k ±0.25%, 1/2w	291880	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R42	Res, met flm, 280Ω ±0.25%, 1/8w	296301	1		
R43	Res, var, cermet, 5k ±10%, 1/2w	288282	1		
R44	Res, met flm, 20k ±1%, 1/8w	291872	1		
R45, R63	Res, comp, 2k ±5%, 1/4w	202879	2		
R46, R47	Res, comp, 75k ±5%, 1/4w	220525	2		
R48	Res, var, cermet, 500Ω ±10%, 1w	291120	1		
R51	Res, met flm, 1.05M, 1%, 1/8w	260737	1		
R52	Res, met flm, 1M, 1%, 1/8w	268797	1		
R53	Res, var, cermet, 100k ±10%, 1/2w	288308	1		
R54	Res, met flm, 64.9k ±1%, 1/8w	260760	1		
R56	Res, met flm, 130k ±1%, 1/8w	221648	1		
R58	Res, met flm, 261k ±1%, 1/8w	288449	1		
R60	Res, met flm, 523k ±1%, 1/8w	260752	1		
R64	Res, comp, 2.7k ±5%, 1/4w	170720	1		
R65, R68, R71	Res, comp, 22k ±5%, 1/4w	148130	3		
R66, R67, R69, R70, R72, R73	Res, comp, 4.3k ±5%, 1/4w	193375	6		
R74	Res, met flm, 9.53k ±0.5%, 1/8w	260836	1		
R75	Res, comp, 220Ω ±5%, 1/4w	147959	1		
R76	Res, comp, 18k ±5%, 1/4w	219022	1		
R77	Res, comp, 1M ±5%, 1/4w	182204	1		
R78	Res, comp, 10Ω ±5%, 1/4w	147868	1		
R79	Res, comp, 22M ±5%, 1/4w	221986	1		
U2	IC, Operational amplifier	271502	1		
U3	Xrst, FET, dual, N-channel	257501	1		
	1 R2, R8, U1 are a matched set. For replacement order REF AMP SET P/N 290759				
	2 R12, R13, R35, R55, R57, R59 and R61 are a matched set. For replacement order P/N 289710.				

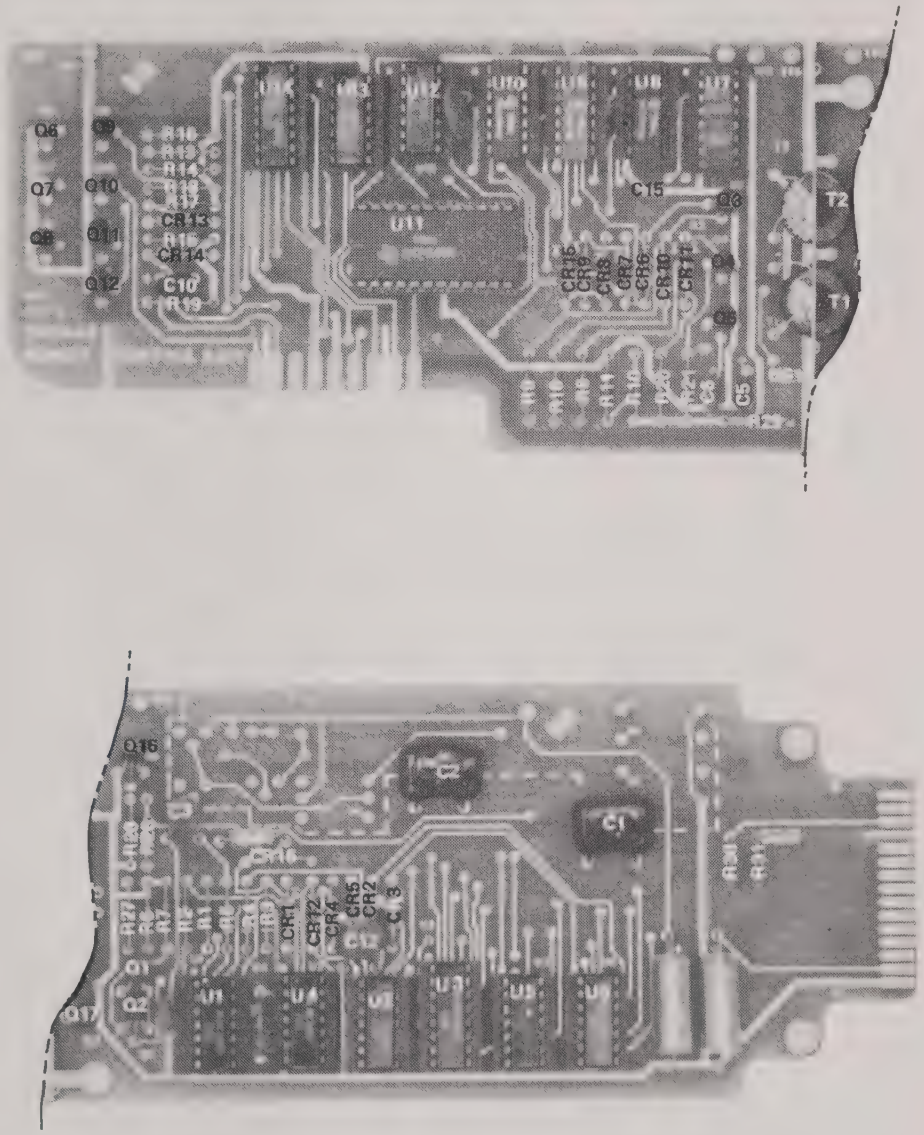


Figure 5-10. REMOTE CONTROL (–08 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A8	REMOTE CONTROL (–08 Option) Figure 5-10	354399	REF		
C1,C2	Cap, mica, 1500 pf ±5%, 500v	148361	2		
C3	Cap, cer, 0.005 uf ±20%, 50v	175232	2		
C4	Cap, Ta, 3.3 uf ±10%, 35v	182808	1		
C5	Cap, Ta, 1.0 uf ±20%, 50v	161919	1		
C6,C12	Cap, cer, 0.0012 uf ±10%, 500v	106732	2		
C7	Not used				
C8,C9	Cap, Ta, 100 uf ±10%, 10v	170456	2		
C10	Cap, Ta, 39 uf ±20%, 6v	163915	1		
C11	Not used				
C13	Cap, cer, 0.005 uf ±20%, 50v	175232	REF		
C14	Cap, cer, 0.0025 uf ±20%, 50v	168435	1		
C15	Cap, mica, 33 uf ±5%, 500v	160317	1		
CR1 thru CR11,CR15	Diode, Ge, 80 mA, 100 piv	149187	12		
CR12,CR13, CR14,CR16, CR22	Diode, Si, 150 mA	203323	5		
DS1	Lamp, Incandescent	272476	1		
Q1,Q2,Q6, thru Q12, Q16	Xstr, Si, NPN	218296	10		
Q3,Q4,Q5	Xstr, Si, PNP	195974	3		
Q13, Q14, Q15	Not used				
Q17	Xstr, photo, light detector, Si	271791	1		
R1,R2	Res, comp, 820Ω ±5%, ¼w	148015	2		
R3, R29	Res, comp, 47Ω ±5%, ¼w	147892	2		
R4, R5	Res, comp, 1k ±5%, ¼w	148023	2		
R6, R7	Res, comp, 100Ω, ±5%, ¼w	147926	2		
R8,R9,R18	Res, comp, 33Ω ±5%, ¼w	147967	3		
R10	Res, comp, 4.7k ±5%, ¼w	148056	1		
R11	Res, comp, 2.2k ±5%, ¼w	148049	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R12	Not used				
R13, R14, R15, R28	Res, comp, 5.6k ±5%, 1/4w	148080	4		
R16, R17	Res, comp, 560Ω ±5%, 1/4w	147991	2		
R18, R27	Res, comp, 10k ±5%, 1/4w	148106	2		
R19	Res, comp, 4.7k ±5%, ¼w	148072	3		
R20, R21	Res, comp, 1.2k ±5%, 1/4w	190371	2		
R22 thru R25	Not used				
R26	Res, comp, 3.9k ±5%, 1/4w	148064	1		
R30, R31	Res, comp, 4.7k ±5%, 1/4w	148072	REF		
T1, T2	Xfmr, pulse	311670	2		
U1	IC, TTL, Quad 2-Input Nor Gate	288845	1		
U2	IC, DTL, Binary Counter	267153	1		
U3	IC, TTL, Digital Multi-plexer	288852	1		
U4, U12, U13	IC, DTL, Quad 2-Input Nand Gate	268375	3		
U5, U6	IC, DTL, Triple 3-Input Nand Gate	266312	2		
U7	IC, TTL, Dual J-K Flip-Flop	268441	1		
U8, U9, U10	IC, DTL, J-K Flip-Flop	288803	3		
U11	IC, TTL, 8-bit latch	288837	1		
U14	IC, TTL, inverting, non-inverting	288829	1		
	Socket, IC, 14 pin dual, (use with U1, U2, U4, U5, U6, U8, U9, U10)	291542	8		
	Socket, IC, 16 pin dual (Use with U3, U7, U14)	291534	3		
	Socket, IC, 24 pin (use with U11)	292946	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A9A	**DATA OUTPUT UNIT NO. 1 (–07 Option)** **Figure 5-11**	290676	REF		
C1, C2	Cap, cer, 0.025 uf ±20%, 50v	168435	2		
C3, C4	Cap, elect, 200 uf +50/–10%, 10v	236935	2		
C5	Cap, cer, 0.002 uf ±GMV, 1kv/2kv	105569	1		
C6, C7	Cap, cer, 0.005 uf ±20%, 50v	175232	4		
C8, C9, C11	Cap, cer, 0.0012 uf ±10%, 500v	106732	6		
C10, C16, C19	Cap, cer, 0.0012 uf ±10%, 500v	106732	REF		
C12, C13	Cap, cer, 500 pf ±10%, 1kv/2250	105692	2		
C14	Cap, cer, 0.01 uf ±20%, 100v	149153	1		
C15, C18	Cap, cer, 0.005 uf ±20%, 50v	175232	REF		
C17	Cap, cer, 0.025 uf ±20%, 50v	168435	REF		
CR1 thru CR8, CR10 thru CR26, CR28	Diode, Ge, 80 mA, 100 piv	149187	26		
CR9, CR27	Diode, Si, 150 mA	203323	2		
J19	Conn, PCB to cable, 34 contact	295337	1		
Q1, Q2	Xstr, Si, PNP	195974	2		
Q3 thru Q8	Xstr, Si, NPN	218396	6		
R1 thru R6, R27, R28, R30	Res, comp, 4.7k ±5%, 1/4w	148072	9		
R7, R8, R17, R19 thru R22, R33, R34	Res, comp, 1k ±5%, 1/4w	148023	9		
R9, R10	Res, comp, 82Ω ±5%, 1/4w	149484	2		
R11, R14, R15	Res, comp, 10k ±5%, 1/4w	148106	3		
R12, R13, R29	Res, comp, 3.3k ±5%, 1/4w	148056	5		
R16	Not used				
R18	Res, comp, 150Ω ±5%, 1/4w	147934	1		

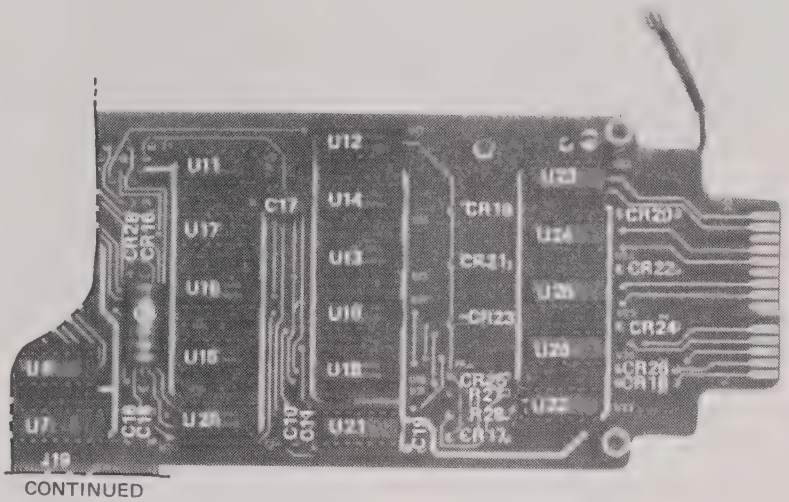


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FIGURE 5-12

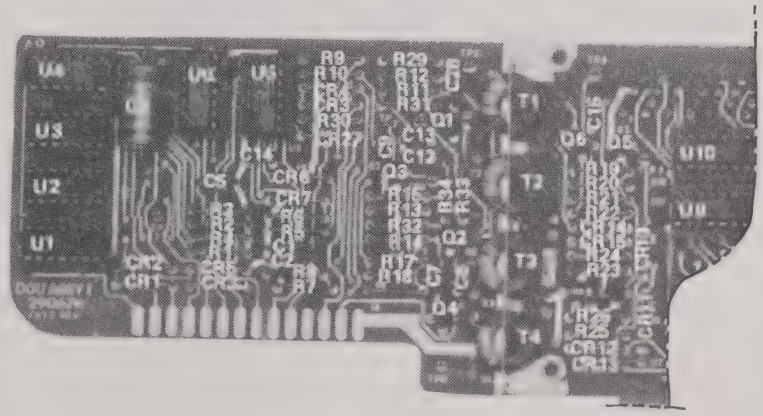


Figure 5-11. DATA OUTPUT UNIT No. 1 (–07 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R23, R24	Res, comp, 100Ω ±5%, 1/4w	147926	2		
R25, R26	Res, comp, 22k ±5%, 1/4w	148130	2		
R31, R32	Res, comp, 3.3k ±5%, 1/4w	148056	REF		
T1 thru T4	Xfmr, pulse	275362	4		
U1, U2, U3	IC, DTL, Triple 3-Input Nand Gate	266312	3		
U4	IC, TTL, Quad 2-Input Nor Gate	268540	1		
U5	IC, TTL, Hex Inverter Buffer/Driver	288605	1		
U6	IC, DTL, Dual 4-Input Nand	268383	1		
U7	IC, TTL, Dual J-K Flip-Flop	268441	1		
U8, U9, U10, U21	IC, DTL, Dual J-K Flip-Flop	288803	4		
U11 thru U16, U18, U19, U20	IC, DTL, Dual J-K Flip-Flop	288811	9		
U17	IC, TTL, Quad 2-Input Nor Gate	288845	1		
U22 thru U26	IC, DTL, Quad 2-Input Nand Gate	268375	5		
	Socket, IC, 14 contact	291542	20		
	Socket, IC, 16 contact	291534	1		

CONTINUED
FIGURE 5-11

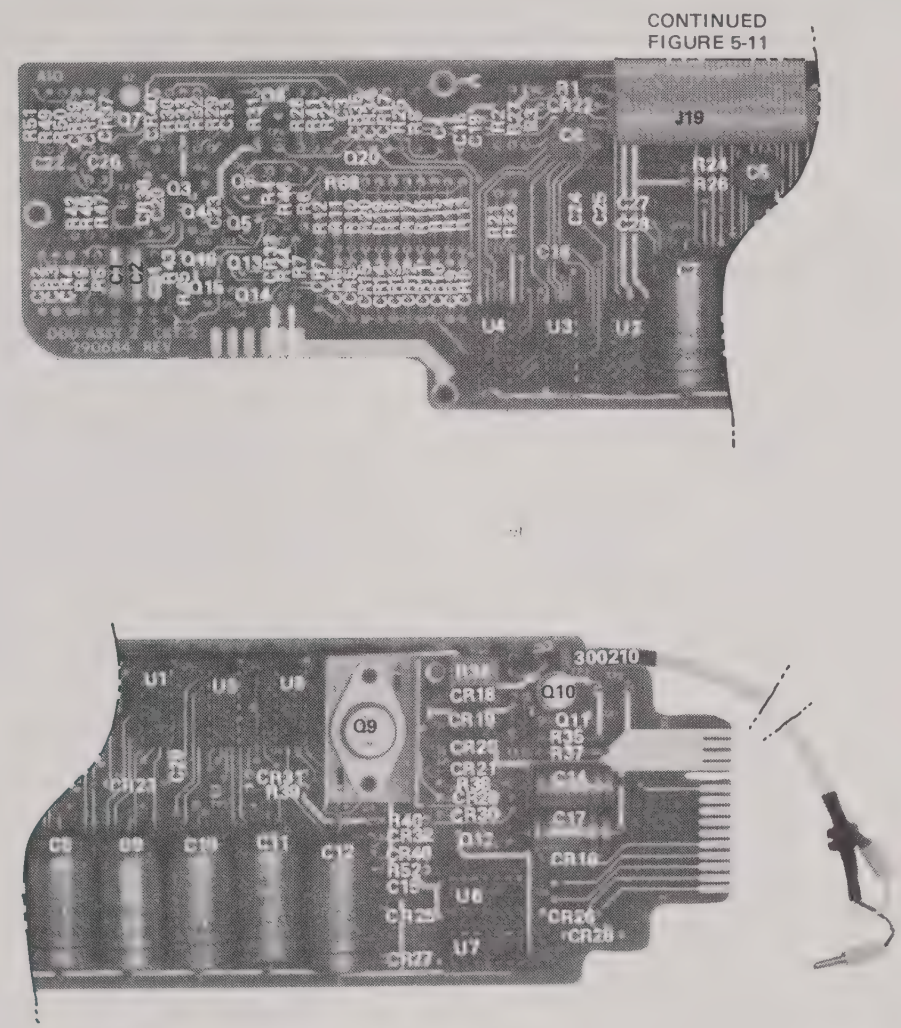


Figure 5-12. DATA OUTPUT UNIT No. 2 (–07 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A10	**DATA OUTPUT UNIT NO. 2 (–07 Option) Figure 5-12**	290684	REF		
C1, C2	Cap, Ta, 3.3k uf ±5%, 20v	271320	2		
C3	Cap, plstc, 0.1 uf ±10%, 250v	161992	2		
C4,C5,C6, C22	Cap, cer, 0.025 uf ±20%, 50v	168435	5		
C7 thru C12	Cap, elect, 1000 uf +50/ –10%, 10v	289132	6		
C13	Cap, mica, 1500 pf ±5%, 500v	148361	1		
C14	Cap, elet400 uf +50/–10%, 4v	187773	1		
C15,C16, C25, C28, C29	Cap, cer, 0.0012 uf ±10%, 500v	106732	5		
C17	Cap, elect, 200 uf +50/–10%, 10v	236935	1		
C18	Cap, cer, 100 pf ±10%, 1kv	105593	1		
C19	Cap, cer, 0.01 uf ±20%‘ 100v	149153	3		
C20	Cap, plst, 0.1 uf ±10%, 250v	161992	REF		
C21	Cap, Ta, 0.68 uf ±10%, 35v	182790	1		
C23, C24	Cap, cer, 0.01 uf ±20%, 100v	149153	REF		
C26	Cap, cer, 0.025 uf ±20%, 50v	168435	REF		
C27	Cap, cer, 0.01 uf ±20%, 100v	149153	REF		
CR1	Not used				
CR2 thru CR15,CR29 CR30,CR32 thru CR35, CR41	Diode, Si, 150 mA	203323	22		
CR16, CR17, CR22, CR23, CR25 thru CR28, CR31, CR36 thru CR40	Diode, Ge, 80 mA, 100 piv	149187	14		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
CR18, CR21	Diode, Si, lamp, 100 piv	116111	2		
CR24	Diode, zener, 3.9v	113316	1		
CR42	Not used				
J19	Conn, PCB to cable, 34 contact	295337	1		
Q1, Q2	Not used				
Q3, Q20	Xstr, Si, PNP	195974	2		
Q4, Q6, Q13	Xstr, si, PNP	229898	3		
Q5, Q11	Xstr, Si, NPN	168708	2		
Q7, Q12, Q14, Q15, Q16	Xstr, Si, NPN	218396	6		
Q8	Xstr, Si, NPN	218081	1		
Q9	Xstr, Si, NPN, with heat sink	288381	1		
Q10	Xstr, Si, NPN	150359	1		
R1	Res, comp, 150Ω ±5%, 1/4w	147934	1		
R2, R35	Res, comp, 5.6k ±5%, 1/4w	148080	2		
R3, R24, R26, R30, R41, R42	Res, comp, 4.7k ±5%, 1/4w	148072	7		
R4, R27, R40, R47	Res, comp, 1k ±5%, 1/4w	148023	4		
R5	Res, comp, 910Ω ±5%, ¼w	203851	1		
R6	Res, comp, 100k ±5%, 1/4w	148189	1		
R7	Res, comp, 1k ±5%, 1/4w	148023	REF		
R8	Res, comp, 4.7k ±5%, 1/4w	148072	REF		
R9	Res, comp, 220k ±5%, 1/4w	160937	1		
R10	Res, met flm, 82.5k±1%, 1/8w	246223	1		
R11, R17	Res, met flm, 49.9k ±1%, 1/8w	268821	2		
R12, R18	Res, met flm, 866Ω ±1%, 1/8w	248641	2		
R13	Res, met flm, 200k ±1%, 1/8w	261701	1		
R14	Res, met flm, 11.5k ±1%, 1/8w	267138	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R15	Res, met flm, 715k ±1%, 1/8w	236836	1		
R16	Res, met flm, 3.57k ±1%, 1/8w	226217	1		
R19	Res, met flm, 121k ±1%, 1/8w	229369	1		
R20	Res, met flm, 1.02k ±1%, 1/8w	223545	1		
R21	Res, comp, 470Ω ±5%, 1/4w	147983	1		B
R22, R32, R49, R51	Res, comp, 2.2k ±5%, 1/4w	148049	4		
R23	Res, comp, 10k ±5%, 1/4w	148106	3		B
R25	Res, comp, 100k ±5%, 1/4w	147926	1		
R28, R33	Res, comp, 6.8k ±5%, 1/4w	148098	2		
R29	Res, comp, 2.7k ±5%, 1/4w	170720	1		
R31	Res, comp, 1.5k ±5%, 1/4w	148031	1		
R34, R39	Res, comp, 3.9k ±5%, 1/4w	148064	2		
R36	Res, var, cer met, 500Ω ±10%, 1/2w	291120	1		
R37	Res, met flm, 100Ω ±1%, 1/8w	168185	1		
R38	Res, comp, 47Ω ±5%, 1/4w	147892	1		
R43	Res, comp, 22k ±5%, 1/4w	148130	1		
R44	Res, comp, 56k ±5%, 1/4w	170738	1		
R45	Res, comp, 180k ±5%, 1/4w	193441	1		
R46, R52	Res, comp, 10k ±5%, 1/4w	148106	REF		
R48	Res, comp, 12k ±5%, 1/4w	159731	1		
R50	Res, comp, 8.2k ±5%, 1/4w	160796	1		
R60	Res, comp, 10k ±5%, ¼w	148106	REF		
R61	Res, comp, 68k ±5%, ¼w	148171	1		
U1	IC, DTL, Hex Inverter	286367	1		
U2	IC, TTL, Dual J-K Flip-Flop	268441	1		
U3,U5	IC, DTL, Triple 3-Input Nand Gate	266312	2		
U4, U6, U7, U8	IC, DTL, Quad 2-Input Nand Gate	268375	4		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	Socket, IC, 14 contact	291542	4		
	Socket, IC, 16 contact	291534	1		
	Input cable, Pwr, DOU	300210	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A11	**EXTERNAL REFERENCE (–04 Option) Figure 5–13**	290692	REF		
C1,C5	Cap, plstc, 0.047uf ±10%, 250v	162008	2		
C2,C4	Cap, cer, 180pf ±10%, 500v	105890	2		
C3	Cap, plstc, 0.22uf ±10%, 250v	194803	1		
C6,C8	Cap, mica, 390pf ±5%, 500v	148437	2		
C7	Cap, mica, 33pf ±5%, 500v	160317	1		
CR1 thru CR8	Diode, Si, 150 mA	203332	8		
K1	Coil, Reed Relay Switch, dryreed	269019 289850	1 1		
Q1,Q2	Xstr, J–FET, N–Channel	288324	2		
Q3,Q4,Q5	Xstr, Si, NPN	218396	3		
R1	Res, ww, 298.8k	1			
R3	Res, ww, 698.8k	1			
R2	Res, var, cermet, 2k ±10%, 1/2w	285163	1		
R4,R10	Res, comp, 10k ±5%, 1/4w	278309	2		
R5,R7	Res, comp, 220k ±5%, 1/4w	160937	2		
R6	Res, comp, 22k ±5%, 1/4w	148130	1		
R8	Res, comp, 1M ±5%, 1/4w	182204	1		
R9	Res, comp, 47k ±5%, 1/4w	148163	1		
R11,R14	Res, ww, 15.0k ±0.1%, 1/4w	289751	2		
R12	Res, var, cermet, 50Ω ±10%, 1w	285122	1		
R13	Res, met flm, 35.7k ±1%, 1/8w	288480	1		
R15,R16, R17	Res, comp, 33k ±5%, 1/4w	148155	3		
U1	IC, Operational Amplifier	271502	1		
U2	Xstr, FET, dual P–Channel	268011	1		
U3	Xstr, FET, dual N–Channel	267963	1		
	Cable, input, ext REF	300533	1		
1	For replacement order Ext REF Divider set P/N 278309				

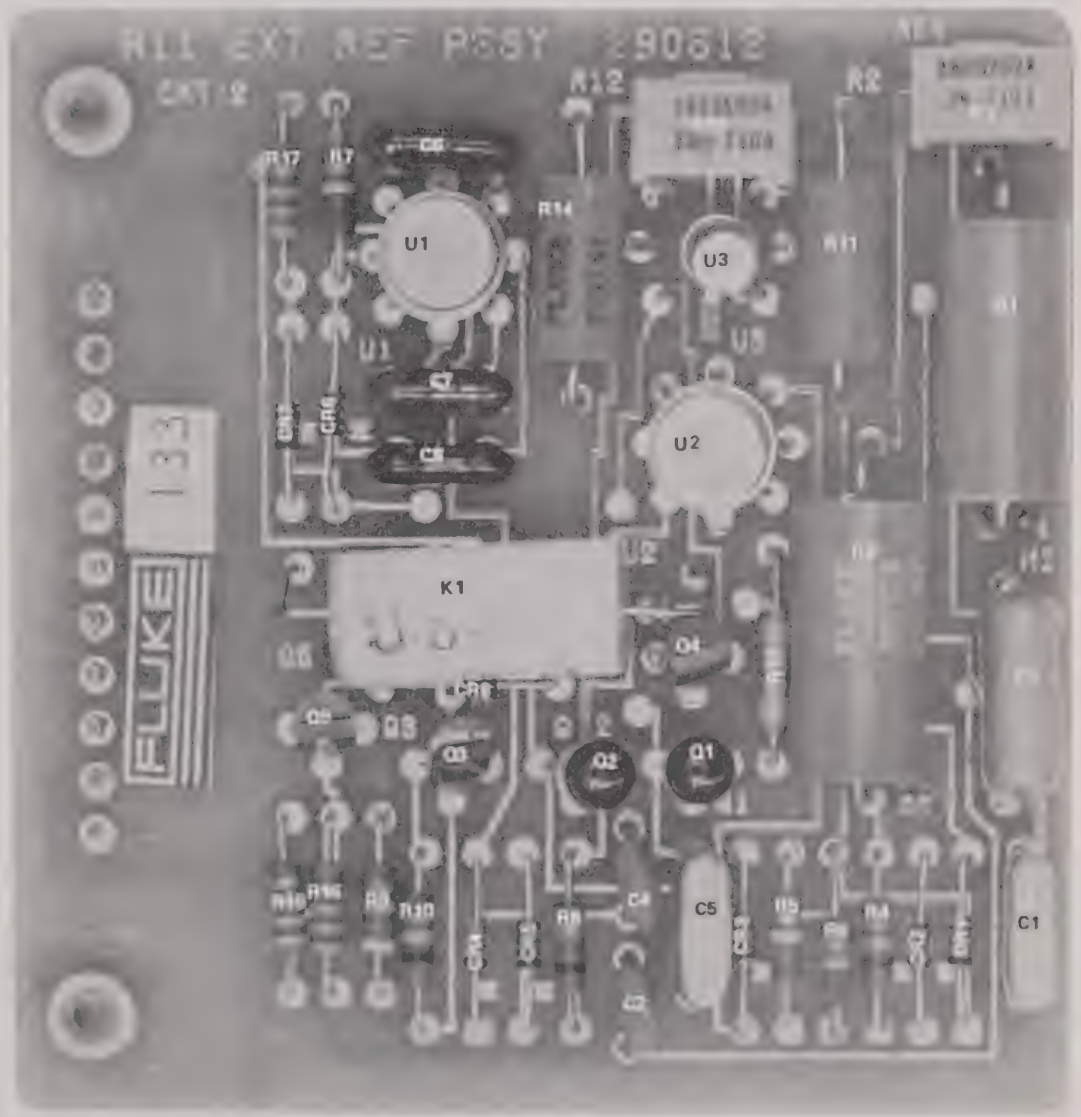


Figure 5-13. EXTERNAL REFERENCE (–04 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A12	**DISPLAY ASSEMBLY** **Figure 5–14**	2	REF		
CR1,CR6 thru CR9	Diode, Si, 150 mA	203323	5		
CR2 thru CR5	Not used				
DS1	Tube, polarity indicator	272922	1		
DS2	Lamp, neon	266478	1		
DS3 thru DS6	Tube, neon readout	271494	4		
DS7	Lamp, neon	293332	1		
DS8	Lamp, incandescent, 28v	246686	1		
J12	Conn, PCB to cable, 34 contact	295337	1		
Q1 thru Q4,Q18	Xstr, Si, PNP	266619	5		
Q5 thru Q8,Q17	Xstr, Si, NPN	218511	5		
Q9 thru Q14	Xstr, Si, NPN	245480	6		
Q15,Q16	Xstr, J–FET, N–Channel	288324	2		
R1,R3,R4 R6,R18, R21	Res, comp, 1k ±5%, 1/4w	148023	6		
R2	Res, comp, 820Ω ±5%, 1/4w	148015	1		
R5	Res, comp, 270Ω ±5%, 1/4w	160804	1		
R7,R8,R19 R20,R22	Res, comp, 11k ±5%, 1/4w	221580	5		
R9,R11	Res, comp, 1.2k ±5%, 1/4w	190371	2		
R10,R13 thru R17	Not used				
R12	Res, comp, 1.3k ±5%, 1/4w	234252	1		
R23	Res, comp, 3.9k ±5%, 1/4w	148064	1		

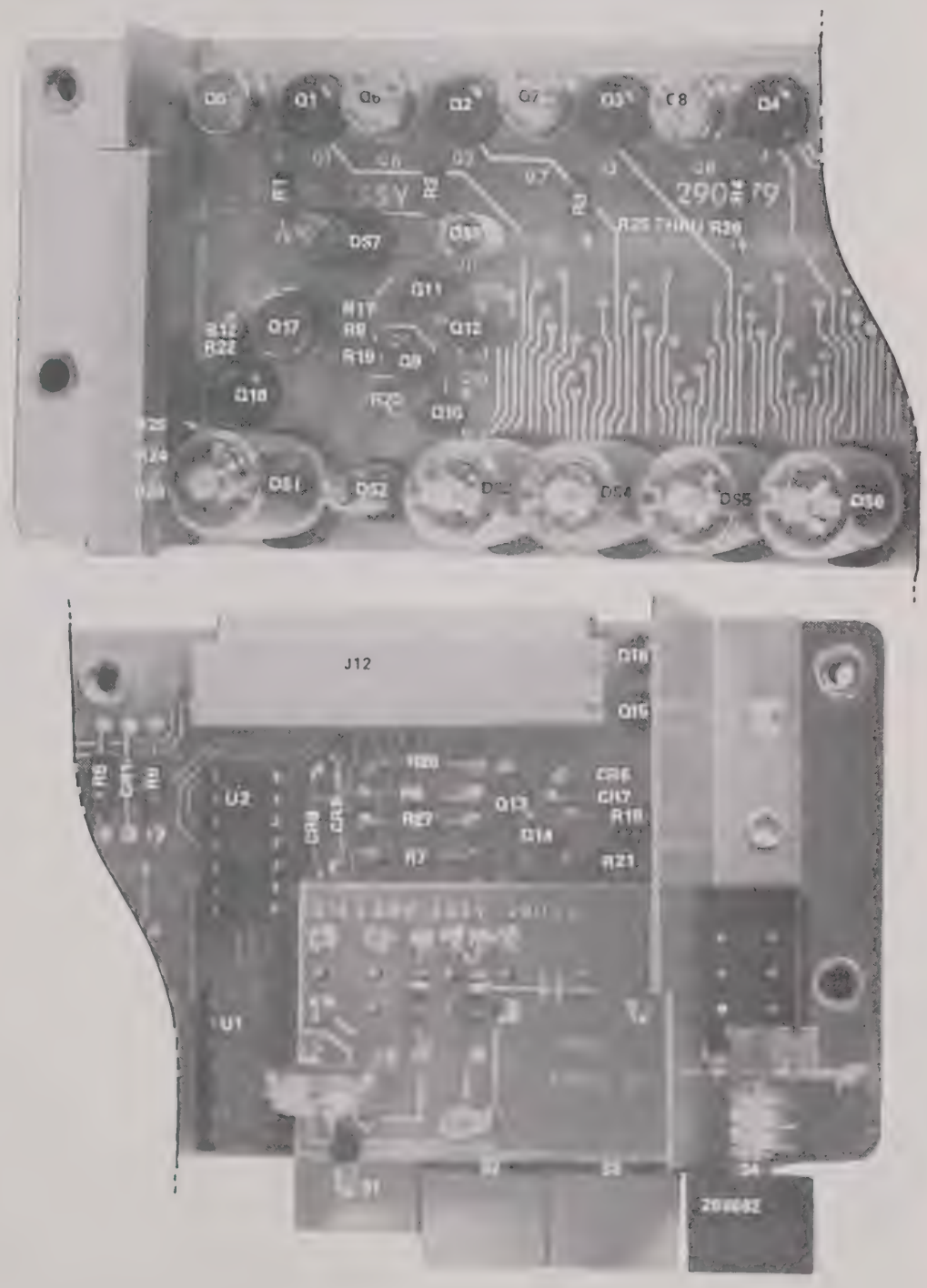


Figure 5-14. DISPLAY ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R24 thru R27	Res, comp, 220k ±5%, 1/4w	160937	4		
R28 thru R36	Res, network, 8 piece set	327585	1		
S1 thru S4	Switch assembly, FILTER, EXT REF, REMOTE, ON–OFF	291484	1		
U1	IC, Decoder Driver, DM/SN7441AN,NS8840N	267211	1		
U2	IC, TTL, Hex Inverter	292979	1		
	Pushbutton, green	268862	1		
	Socket, lamp, DS2	297952	1		
	Socket, lamp, DS7	279372	1		
	Socket, IC, 14 contact	291542	1		
	Socket, IC, 16 contact	291534	1		
	2 P/N 290379 and 290700 are a matched set, when ordering use P/N 304089				

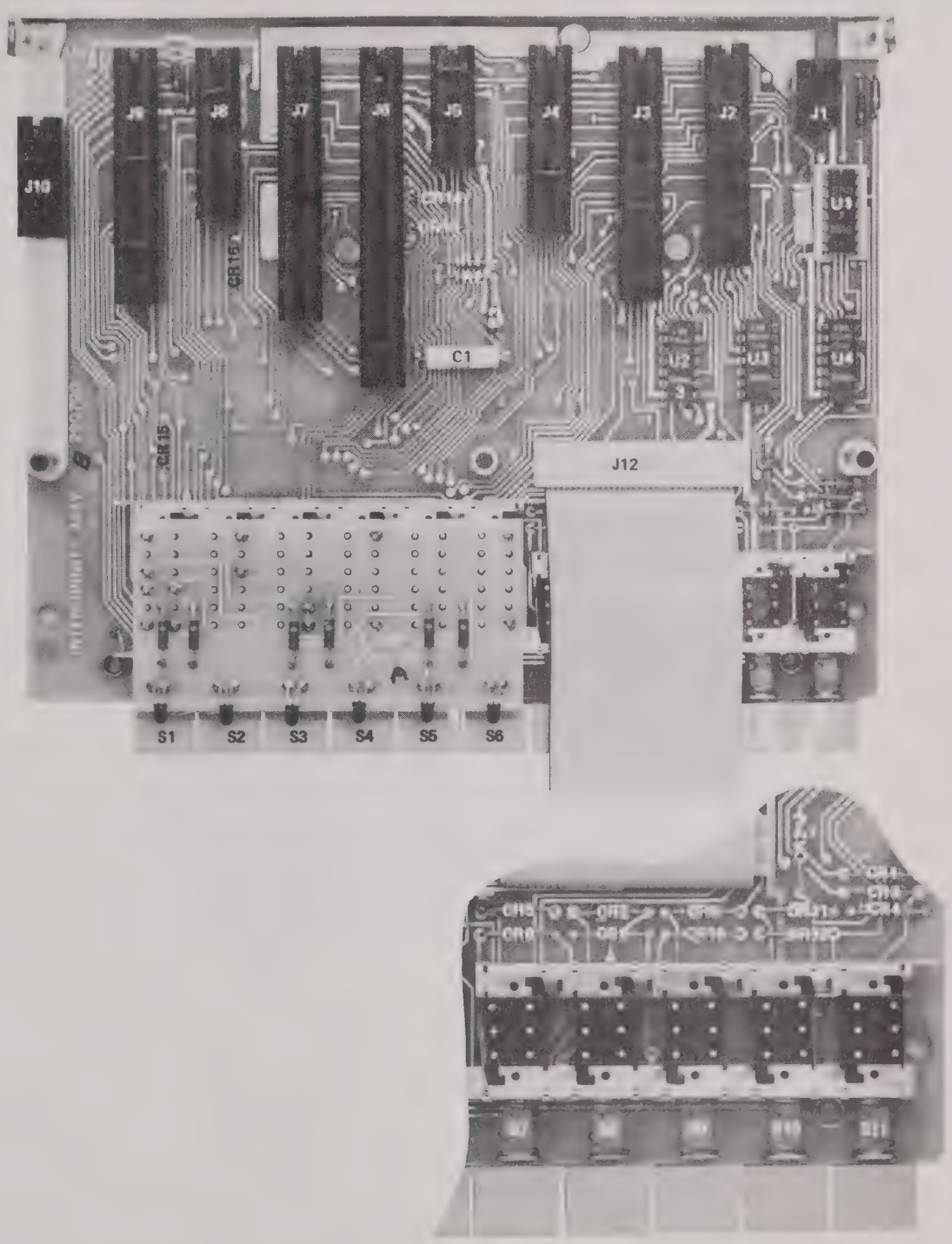


Figure 5-15. INTERCONNECT ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A13	**INTERCONNECT ASSEMBLY** **Figure 5–15**	3	REF		
C1	Cap, plstc, 0.022uf ±20%, 100v	106039	1		
C2	Cap, plstc, 0.01uf ±20%, 100v	235390	1		
CR1 thru CR16	Diode, Ge, 80 mA, 100 piv	149187	16		
J1	Conn, female, 6contacts	291625	1		
J2	Conn, female, 24 contacts	295352	1		
J3,J9	Conn, female, 28 contacts	291930	2		
J4	Conn, female, 20 contacts	291914	1		
J5,J10	Conn, female, 12 contacts	291898	2		
J6	Conn, female, 38 contacts	291955	1		
J7	Conn, female, 30 contacts	291948	1		
J8	Conn, female, 18 contacts	291906	1		
J12	Conn, PCB to Cable, 34 contact	295337	1		
R1,R2	Res, comp, 4.7k ±5%, 1/4w	148072	2		
R3	Res, comp, 680Ω ±5%, 1/4w	148007	1		
R4, R5, R6, R7	Res, comp, 2.2k ±5%, ¼w	148047	4		
S1 thru S11	Switch assembly, FUNCTION & RANGE	291492	1		
U1	IC, TTL, J-K flip flop	268441	1		
U2	IC, DTL, Hex Inverter	268367	1		
U3,U4	IC, DTL, Triple 3-Input Nand Gate	266312	2		
	Socket, IC, 16 contact	291534	1		
	3 P/N 290379 and 290700 are a matched set. When ordering, use P/N 304089				

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A14	**LAMP ASSEMBLY (UPPER)** **Figure 5–16**	290718	REF		
DS1,DS2	LED, Ga - As-P Red, Visable	309777	2		
R1	Res, var, cbn, 100k ±30%, 1/4w	223149	1		
R2,R3	Res, comp,150Ω±5%, 1/4w	147934	2		

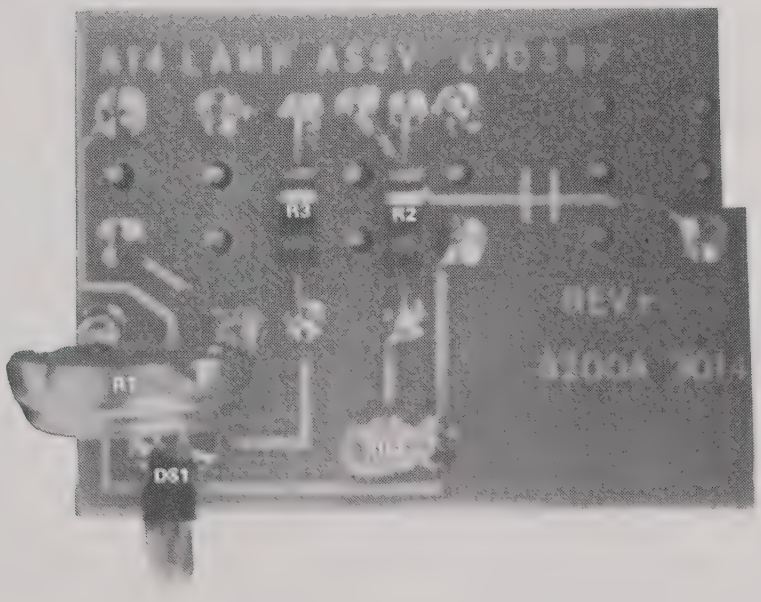


Figure 5-16. LAMP ASSEMBLY (UPPER)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A15	**LAMP ASSEMBLY (LOWER)** **Figure 5–17**	290726	REF		
DS1 thru DS6	LED, Ga - As - P, Red, visible	369777	6		
R1 thru R6	Res, comp,150Ω±5%, 1/4w	147934	6		

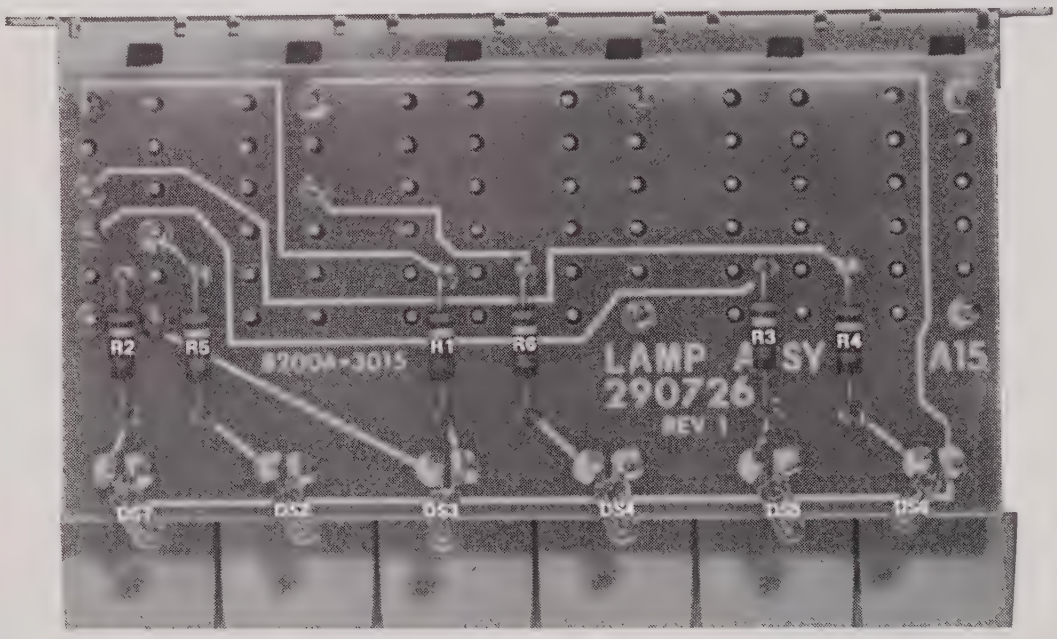
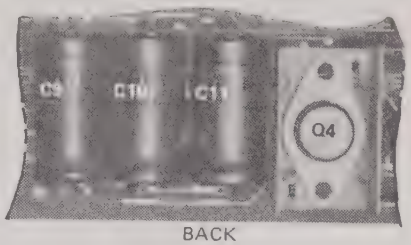
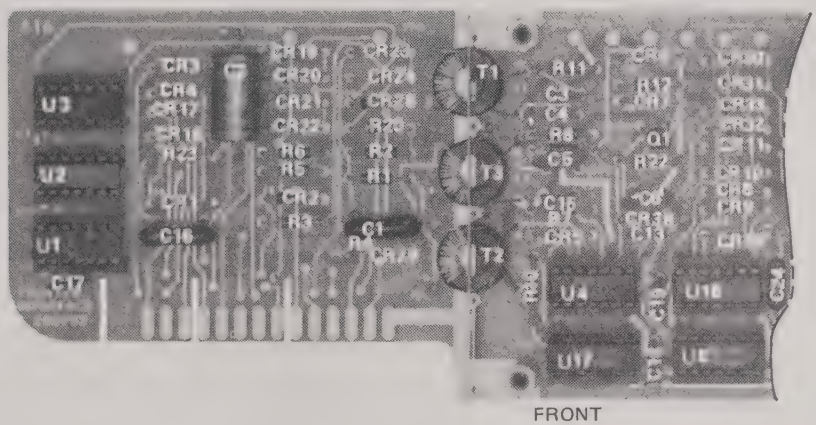


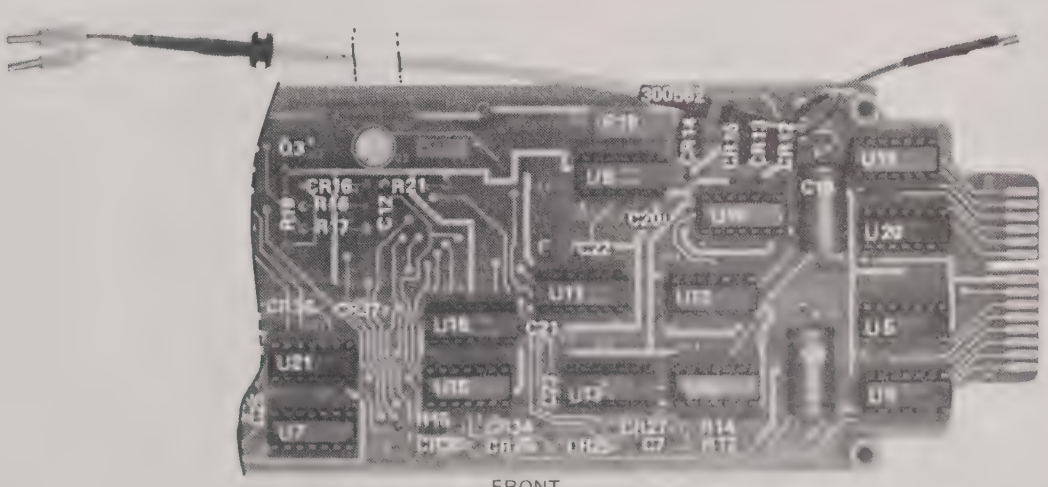
Figure 5-17. LAMP ASSEMBLY (LOWER)



BACK



FRONT



FRONT

Figure 5-18. PRINTER OUTPUT (–06 Option)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A16	**PRINTER OUTPUT (–06 Option) Figure 5–18**	290783	REF		
C1,C16	Cap, mica, 2200pf ±5%, 500v	148346	2		
C2,C14	Cap, elect, 200uf +50/–10%, 10v	236935	2		
C3,C4, C23,C25	Cap, cer, 0.005uf ±20%, 50v	175232	4		
C5,C6,C15	Cap, cer, 0.025uf ±20%, 50v	168435	3		
C7,C12	Cap, cer, 0.0012uf ±10%, 500v	106732	6		
C8	Cap, elect, 400uf +50/–10%, 4v	187773	1		
C9,C10, C11	Cap, elect, 1,000uf +50/–10%, 10v	289132	3		
C13, C17,C22	Cap, cer, 0.01uf ±20%, 100v	149153	3		
C18 thru C21	Cap, cer, 0.0012uf ±10%, 500v	106732	REF		A
C24	Cap, mica, 220pf ±5%, 500v	170423	1		A
CR1 thru CR10 CR17 thru CR28 CR30 thru CR38	Diode, Ge, 80 mA, 100piv	149187	31		
CR11, CR29	Diode, Si, 150 mA	203323	3		
CR12 thru CR15	Diode, Si, 1v lamp, 100 piv	116111	4		
CR16	Diode, zener, 3.9v	113316	1		
CR39	Diode, Si, 150 mA	203323	REF		A
Q1	Xstr, Si, PNP	195974	1		
Q2	Xstr, Si, NPN				
Q3	Xstr, Si, NPN	168708	1		
Q4	Xstr, Si, NPN	288381	1		
R1,R2, R8,R22	Res, comp, 10k ±5%, 1/4w	148106	5		
R3,R20	Res, comp, 470Ω ±5%, 1/4w	147983	2		
R4,R11, R12	Res, comp, 150Ω ±5%, 1/4w	147934	3		
R5,R6	Res, comp, 82Ω ±5%, 1/4w	149484	2		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
R7	Res, comp, 220Ω ±5%, 1/4w	147959	1		
R9,R13, R14	Res, comp, 4.7k ±5%, 1/4w	148072	3		
R10	Res, comp, 10k ±5%, 1/4w	148106	REF		A
R15	Res, comp, 47Ω ±5%, 1/4w	147892	1		
R16	Res, comp, 3.9k ±5%, 1/4w	148064	1		
R17	Res, comp, 5.6k ±5%, 1/4w	148080	1		
R18	Res, var, cermet, 500Ω ±10%, 1w	291120	1		
R19	Res, met flm, 100Ω ±1%, 1/8w	168195	1		
R21	Res, comp, 8.2k ±5%, 1/4w	160796	1		
R23	Res, comp, 3.3k ±5%, 1/4w	148056	1		
T1,T2,T3	Xfmr, pulse	311670	3		
U1	IC, TTL, Hex Inverter, Buffer/Driver	288605	1		
U2	IC, DTL, Dual 4–Input Nand	268383	1		
U3,U5,U6 U19,U20, U21	IC, TTL, Dual, IC, TTL, Hex Inverter	268367	6		
U4,U8 thru U15, U17	IC, DTL, Dual J–K Flip–Flop	288811	10		
U7	IC, TTL, Quad 2–Input Nor Gate	288845	1		
U16	IC, DTL, Dual J–K Flip–Flop	288803	1		
U18	IC, DTL, Quad 2–Input Nand Gate	268375	1		
	Cable, pwr input, printer output	300582	1		
	Socket, IC, 14 contact	291542	19		

MANUFACTURERS' CROSS REFERENCE LIST

FLUKE STOCK NO.	MFR.	MFR. PART NO.
105569	71590	DA140-139CB
105593	71590	DD-101
105692	71590	Type CE
105890	71590	BB60181KS3N
106039	84411	Type 663UW
106732	71590	CF-122
108456	01121	EB3305
108951	01121	EB5115
112383	05277	1N4822
113316	07910	1N748
116111	05277	1N4817
147868	01121	CB1005
147884	01121	CB2205
147892	01121	CB4705
147918	01121	CB6805
147926	01121	CB1015
147934	01121	CB1515
147942	01121	CB1815
147959	01121	CB2215
147967	01121	CB3315
147975	01121	CB3915
147983	01121	CB4715
147991	01121	CB5615
148007	01121	CB6815
148015	01121	CB8215
148023	01121	CB1025
148031	01121	CB1525
148049	01121	CB2225
148056	01121	CB3325
148064	01121	CB3925
148072	01121	CB4725
148080	01121	CB5625
148098	01121	CB6825
148106	01121	CB1035
148114	01121	CB1535
148122	01121	CB1835
148130	01121	CB2235
148148	01121	CB2735
148155	01121	CB3335
148163	01121	CB4735
148171	01121	CB6835
148189	01121	CB1045
148346	14655	CD19F222J
148361	14655	CD19F152J
148387	14655	CD19F102J
148437	14655	CD15F391J
148445	14655	CD15F331J
148452	14655	CD15F271J
148478	14655	CD15F151J
148494	14655	CD15F101J
148502	14655	CD15E820J
148510	14655	CD15F680J
148569	14655	CD15C150J
148551	14655	CD15E220J
148577	14655	CD15C050K
148643	95303	2N1307
149153	56289	C032B101F103M
149161	56289	55C23A1
149187	93332	1N270
149484	01121	CB8205
150359	95303	2N3053
153858	71400	AGC
155192	91637	Type MFF 1/2

MANUFACTURERS' CROSS REFERENCE LIST

FLUKE STOCK NO.	MFR.	MFR. PART NO.
159582	56289	192P10292
159731	01121	CB1235
159764	18612	V53-1
159855	07910	CS23030
160317	14655	CD15E330J
160796	01121	CB8225
160804	01121	CB2715
160937	01121	CB2245
161331	56289	196D224X0035
161810	03877	SG5658
161919	56289	196D105X0035
161927	56289	196D225X0020
161943	56289	196D475X0020
161992	73445	C280AE/A100K
162008	73445	C280AE/A47K
162776	89536	162776
163915	56289	196D396X006
163931	89536	163931
165886	56289	30D105G025BA4
168153	73445	C437ARF400
168195	91637	TYPE MFF 1/8
168260	91637	TYPE MFF 1/8
168385	84171	PE103G
168435	56289	C128B101H253M
168708	03508	2N3391
170423	14655	CD15F221J
170456	56289	150D107X9010R2
170704	01121	EB9115
170720	01121	CB2725
170738	01121	CB5635
170787	95303	2N3054
175042	01121	CB1825
175208	84171	DM1502K
175216	14655	CD15C0100K
175224	14655	CD15E120J
175232	56289	C023B101E502M
176644	14655	CD19F362G
177998	14655	CD15E270J
180455	07910	IN749A
180554	07910	CD12599
182204	01121	CB1055
182212	01121	CB1545
182691	01295	GA3937
182709	01295	GA3938
182790	56289	150D684X9035A2
182816	56289	150D226X9015A2
186296	73445	C426ARE125
187773	73445	C426ARB400
188375	91637	TYPE MFF 1/8
188441	01121	CB4745
188458	01121	CB8235
190371	01121	CB1225
190520	01121	EB1071
190728	24655	0938-9751
192898	91637	TYPE MFF 1/8
193300	01121	CB9135
193318	01121	CB9125
193334	01121	CB5135
193342	01121	CB5125
193375	01121	CB4325
193391	01121	CB3905
193433	01121	CB2435
193441	01121	CB1845

MANUFACTURERS' CROSS REFERENCE LIST

FLUKE STOCK NO.	MFR.	MFR. PART NO.
193458	01121	CB1245
193482	01121	CB2015
193623	56289	196D106X0015
194803	73445	C280AEA220K
194944	01121	CB1065
195974	04713	2N3906
198267	12617	MRH DT
198390	01121	CB2255
202879	01121	CB2025
203323	03508	DHD1105
208975	14655	CD19F472J
215897	04713	2N4126
216986	14655	CD15C080K
217976	91637	TYPE MFF 1/8
218032	01121	CB5115
218081	04713	MPS6520
218206	72982	530-000
218396	07263	2N3904
218511	95303	60994
218693	01121	EB10G5
218818	01121	HB5615
219022	01121	CB1835
220061	01121	CB2745
220525	01121	CB7535
221580	01121	CB1135
221598	01121	CB1335
221606	01121	CB1635
221614	01121	CB2035
221648	91637	TYPE MFF 1/8
221663	91637	TYPE MFF 1/8
221929	01121	CB3635
221986	01121	CB2265
223149	37942	TYPE MTC-1
223529	91637	TYPE MFF 1/8
223545	91637	TYPE MFF 1/8
223552	91637	TYPE MFF 1/8
225755	91637	TYPE MFF 1/4
225961	34333	TYPE SG-8023
226134	14655	CD15F151F500
226142	14655	CD15F331F
226217	91637	TYPE MFF 1/8
226274	82389	46256LFE
229369	91637	TYPE MFF 1/8
229898	04713	MPS6522
229930	91293	JMC-2951
233148	91637	TYPE MFF 1/8
234096	91637	TYPE MFF 1/8
234252	01121	CB1325
234492	73445	C280AE/A33K
234682	01121	CB3045
234708	91637	TYPE MFF 1/8
234989	91637	TYPE MFF 1/8
235226	91637	TYPE MFF 1/8
235259	91637	TYPE MFF 1/8
235283	91637	TYPE MFF 1/8
235333	91637	TYPE MFF 1/8
235390	84411	TYPE 663UW
236836	91637	TYPE MFF 1/8
236935	73445	C426ARD200
237222	91637	TYPE MFF 1/8
241091	91637	TYPE MFF 1/8
245340	91637	TYPE MFF 1/8
245480	07263	S24496

MANUFACTURERS' CROSS REFERENCE LIST

FLUKE STOCK NO.	MFR.	MFR. PART NO.
246223	91637	TYPE MFF 1/8
246611	07910	IN961B
246686	06001	TYPE 7387
246744	01121	CB2705
248641	91637	TYPE MFF 1/8
248807	91637	TYPE MFF 1/8
248906	95303	CA3406
256990	89536	256990
257501	17856	DN423
260315	91637	TYPE MFF 1/8
260562	84411	863UW47391
260695	07910	IN754A
260737	91637	TYPE MFF 1/8
260752	91637	TYPE MFF 1/8
260760	91637	TYPE MFF 1/8
260836	91637	TYPE MFF 1/8
260844	06001	75FIR5A472
261016	80294	TYPE 3329W
261370	22767	S1330
261628	91637	TYPE MFF 1/8
261651	91637	TYPE MFF 1/8
261677	91637	TYPE MFF 1/8
261701	91637	TYPE MFF 1/8
265744	89530	265744
266312	89536	266312
266478	74276	A261
266619	07263	2N4888
267138	91637	TYPE MFF 1/8
267153	04713	MC839P
267211	12040	DM8840N
278666	-01121	EB2225
267880	71450	190PC103B
267963	17896	2N5197
268011	AMI	1-1483
268110	06001	2N6027
268367	04713	MC836P
268375	04713	MC846P
268383	04713	MC832P
268441	18324	C4322B
268540	18324	C4319A
268557	18324	C4321A
268789	91637	TYPE MFF 1/8
268797	91637	TYPE MFF 1/8
268805	91637	TYPE MFF 1/8
268821	91637	TYPE MFF 1/8
268862	71590	J61993
268904	84411	TYPE X 663F
269019	71707	U-6-P
269084	07263	EN2484
269092	89536	269092
271320	56289	150D335X550B
271346	91637	TYPE MFF 1/8
271403	54294	TYPE SP22
271494	83594	B5870ST
271502	27014	LM301A
271577	06001	75F1R5A223
271619	05277	X463UW1009.50
271676	91637	TYPE MFF 1/8
271791	06001	L14B
271924	07910	CFE13041
272070	71707	UD-6-P
272476	71744	TYPE T1
272716	12300	R40-E3B-L-35

MANUFACTURERS' CROSS REFERENCE LIST

FLUKE STOCK NO.	MFR.	MFR. PART NO.
272781	91637	TYPE MFF 1/2
272922	83594	B585-6ST
273151	74970	273-1-2
275362	89536	275362
275552	32767	820-65
275560	32767	820-45
275578	32767	820-55
276980	12969	UZ8712
276691	11236	360T105A
277020	12617	SRR-3
277392	04713	SC14926G
277855	89536	277855
277913	89536	277913
278309	01121	CB1035
279372	89536	279372
280008	89536	280008
280198	89536	280198
282145	56289	HVD-47±10%
283580	56289	3339R8
283705	91637	TYPE MFF 1/2
284075	11726	QD200-78
284091	95348	MR138
284166	82389	EAC301
284174	70903	17250
284695	05277	X463UW6809.50W
284703	05277	X463UW.3309.50W
284760	27014	LM308H
284807	91637	TYPE MFF 1/8
284810	14655	CD15F560F
284836	89536	284836
284877	97137	56351
284893	97137	13351
284901	84171	1PJ822J
284968	30983	TYPE MF9C
285056	01121	HB1045
285106	15818	TCR5309
285114	71450	360S-200B
285122	71450	360S-500A
285130	71450	360S-101A
285148	71450	360S-201A
285155	71450	360S-102A
285163	71450	360S-202A
285171	71450	360S-103A
285312	89536	285312
285361	89536	285361
288225	89536	288225
288233	89536	288233
288282	71450	360S-502A
288290	71450	360S-503A
288308	71450	360S-104A
288324	15818	U2412
288365	27014	LM310H
288381	95303	40372
288431	91637	TYPE MFF 1/8
288449	91637	TYPE MFF 1/8
288480	91637	TYPE MFF 1/8
288514	91637	TYPE MFF 1/8
288548	91637	TYPE MFF 1/8
288597	04713	MC858P
288605	01295	SN7416P
288613	71707	T-48002
288746	56289	39D805F350EJ4
288753	71450	190PC504B

MANUFACTURERS' CROSS REFERENCE LIST

FLUKE STOCK NO.	MFR.	MFR. PART NO.	FLUKE STOCK NO.	MFR.	MFR. PART NO.
288761	49956	RS-2048	290320	89536	290320
288803	01295	SN158097N	290379	89536	290379
288811	04713	MC856P	290452	89536	290452
288829	04713	MC4038P	290577	89536	290577
288837	01295	SN74100N	290619	89536	290619
288845	01295	SN7402N	290627	89536	290627
288852	04713	MC8312P	290635	89536	290635
288928	27014	LM308AH	290643	89536	290643
288951	89536	288951	290668	89536	290668
288977	89536	288977	290676	89536	290676
288985	89536	288985	290684	89536	290684
289009	07910	CD333068	290692	89536	290692
289058	91637	TYPE MFF 1/8	290700	89536	290700
289116	91637	TYPE MFF 1/8	290718	89536	290718
289132	25403	C437ARD1600	290726	89536	290726
289165	91637	TYPE MFF 1/8	290759	89536	290759
289447	91637	TYPE MFF 1/8	290783	89536	290783
289504	91637	TYPE MFF 1/8	290932	89536	290932
289579	91637	TYPE MFF 1/8	290940	89536	290940
289603	91637	TYPE MFF 1/8	290957	89536	290957
289611	91637	TYPE MFF 1/8	291120	71450	360S-501A
289629	01121	CB1855	291393	91637	TYPE MFF 1/8
289637	72982	538-006D-9-35	291484	89536	291484
289678	71450	360S-253A	291492	89536	291492
289710	89536	289710	291534	13511	583529
289751	89536	289751	291542	13511	583527
289850	95348	MR108	291567	27264	09-02-1091
289967	79915	279.100	291625	00779	583650-1
289975	91637	TYPE MFF 1/8	291872	91637	TYPE MFF 1/8
290189	89536	290189	291880	91637	TYPE MFF 1/2
290197	89536	290197	291898	00779	583650-2

MANUFACTURERS' CROSS REFERENCE LIST

FLUKE STOCK NO.	MFR.	MFR. PART NO.
291906	00779	583650-3
291914	00779	583650-4
291930	00779	583650-6
291948	00779	583650-7
291955	00779	583650-8
292029	89536	292029
292284	89536	292284
292318	89536	292318
292490	89536	292490
292649	89536	292649
292656	89536	292656
292870	89536	292870
292946	71785	133-59-02-011
292979	01295	SN7400N
293332	74276	NE97
293522	91637	TYPE MFF 1/8
295014	02660	261-70005
295030	71400	TYPE HTA
295287	89536	295287
295295	98291	011-4017
295337	3M	3402
295352	00779	583650-9
295543	13511	223-1-2-05
295550	13511	223-1-1-05
295584	13511	223-21-01
296301	91637	TYPE MFF 1/8
296582	79915	281005
296665	91637	TYPE MFF 1/8
297952	89536	297952
298976	89536	298976
299404	89536	299404
299818	89536	299818
299826	89536	299826
299834	89536	299834
299842	89536	299842
299867	89536	299867
300202	89536	300202
300210	89536	300210
300228	89536	300228
300533	89536	300533
300558	89536	300558
300566	89536	300566
300574	89536	300574
300582	89536	300582
301796	89536	301796
303255	89536	303255
304006	89536	304006
304071	89536	304071
304089	89536	304089
305268	89536	305268
306027	91637	TYPE MFF 1/8
306266	27012	TYPE AM 1660
308270	89536	308270
308924	89536	308924
308932	89536	308932
309047	89536	309047
309054	89536	309054
309658	12617	MRH-DT
309906	06001	75F1R5A100
309914	06001	75F2R5A823
310045	89536	310045
311019	89536	311019
311670	89536	311670
313270	71707	SP-6H-P

MANUFACTURERS' CROSS REFERENCE LIST

FLUKE STOCK NO.	MFR.	MFR. PART NO.
313833	89536	313833
315655	89536	315655
321430	91637	TYPE MFF 1/8
321448	91637	TYPE MFF 1/8
321455	91637	TYPE MFF 1/8
321463	91637	TYPE MFF 1/8
321471	91637	TYPE MFF 1/8
321489	91637	TYPE MFF 1/8
321497	91637	TYPE MFF 1/8
321505	91637	TYPE MFF 1/8
321588	89536	321588
321646	89536	321646
321653	89536	321653
327585	56289	TYPE 200C
328351	98291	011-4017
328526	89536	328526
329144	89536	329144
329912	27014	LM318H
330118	04222	TYPE C1-1
333161	89536	333161
333179	89536	333179
334615	89536	334615
334722	71450	360S-105A
339317	89536	339317
340133	89536	340133
340141	91637	TYPE MFF 1/8
340158	91637	TYPE MFF 1/8
340166	91637	TYPE MFF 1/8
340174	91637	TYPE MFF 1/8
340182	91637	TYPE MFF 1/8
340208	91637	TYPE MFF 1/8
340216	91637	TYPE MFF 1/8
340224	91637	TYPE MFF 1/8
340232	91637	TYPE MFF 1/8
340240	91637	TYPE MFF 1/8
340257	91637	TYPE MFF 1/8
340265	89536	340265
340273	89536	340273
340281	89536	340281
340323	91637	TYPE MFF 1/4
340745	89536	340745
340851	89536	TYPE MFF 1/8
341057	89536	341057
342519	89536	342519
343103	89536	343103
344283	95275	VY10CA270JA
347963	80294	3329H-J81-3RO
361030	89536	361030

Section 6

Option & Accessory Information

6-1. INTRODUCTION

6-2. This section contains information describing option installation and usable accessories with this instrument.

6-3. OPTIONS

6-4. The installation of the options usable with this instrument are described under headings that list the option name and number. The descriptions give detailed field installation for each option. Operating instructions, maintenance and parts listing for each option appear in the appropriate sections of this manual.

6-5. ACCESSORIES

6-6. Accessories usable with this instrument are described under headings that list the accessory name.

6-7. A listing of included options and accessories is given in the contents at the front of this manual.

Option—01
AC Converter

6-1. INTRODUCTION

6-2. The A5 AC Converter is installed as the –01 Option. It can be installed at the factory during manufacture or later in the field, as desired. The field installation kit for the AC Converter is identified as the 8200A –01K.

6-3. INSTALLATION

6-4. Use the following procedure to install the AC Converter Option in the 8200A DVM.

a. Disconnect the power cord from line power.

b. Remove top outer and guard covers.

c. Remove shield that is installed in the A5 slot by first disconnecting ground lead and then pulling shield up and out of instrument.

d. Determine that connector J5 on A13 Interconnect board, which mates with A5 AC Converter board, is clear of obstructions and that alignment spacer is inserted between the following pin pairs of J5:

5 and 6
11 and 12

e. Check that the shield on AC Converter is securely attached to board.

f. Align the A5 AC Converter board vertically with plastic guide slots on inner vertical faces of guard chassis and slide converter board downward to fully engage board card-edge connector with J5 connector on Interconnect assembly.

g. Dress the twisted pair through slot on inner chassis and route toward front panel INPUT terminals.

h. Connect leads to INPUT terminals: Red to INPUT HI, and Black to INPUT LO.

i. Attach guard and outer covers, connect ac power, and perform receiving inspection test of converter as described in the Performance Test paragraphs of Section 4.

Option—02
MV Convertor

6-1. INTRODUCTION

6-2. The A3 MV Converter is installed as the –02 Option. It can be installed at the factory during manufacture or later in the field, as desired. The field installation kit for the MV Converter is identified as the 8200A–02K.

6-3. INSTALLATION

6-4. Use the following procedure to install the A3 MV Converter Option in the 8200A DVM.

a. Disconnect the power cord from line power.

b. Remove top outer and guard covers.

c. Determine that connector J3 on A13 Interconnect board, which mates with A3 MV Converter board, is clear of obstructions and that alignment spacer is inserted between the following pin pairs of J3:

5 and 6
19 and 20

d. Check that the shield on MV Converter is securely attached to board.

e. Align the A3 MV Converter board vertically with plastic guide slots on inner vertical faces of guard chassis and slide converter board downward to fully engage board card-edge connector with J3 connector on Interconnect assembly.

f. Dress the twisted pair through slot on inner chassis and route toward front panel INPUT terminals.

g. Connect leads to INPUT terminals: Red to INPUT HI, and Black to INPUT LO.

h. Attach guard and outer covers, connect ac power, and perform receiving inspection test of converter as described in the Performance Test paragraphs of Section 4.

Option–03
Ohm Converter

6-1. INTRODUCTION

6-2. The A2 Ohms Converter is installed as the –03 Option. It can be installed at the factory during manufacture or later in the field as desired. The field installation kit for the Ohms Converter is identified as the 8200A–03K.

6-3. INSTALLATION

6-4. Use the following procedure to install the A2 Ohms Converter Option in the 8200A DVM.

a. Disconnect the power cord from line power.

b. Remove top outer and guard covers.

c. Determine that connector J2 on A13 Interconnect board, which mates with A2 Ohms Converter board, is clear of obstructions and that alignment spacer is inserted between the following pin pairs of J2:

9 and 10
21 and 22

d. Align the A2 Ohms Converter board vertically with plastic guide slots on inner vertical faces of guard chassis and slide converter board downward to fully engage board card-edge connector with J2 connector on Interconnect assembly.

e. Dress the twisted pair through slot on inner chassis and route towards front panel INPUT terminals.

f. Connect leads to INPUT terminals: Red to INPUT HI, and Black to INPUT LO.

g. Attach guard and outer covers, connect ac power, and perform receiving inspection test of converter as described in the Performance Test paragraphs of Section 4.

Option–04
External Reference

6-1. INTRODUCTION

6-2. The A11 External Reference is installed as the –04 Option. It can be installed at the factory during manufacture or later in the field, as desired. The Rear Input (Option –05) must be installed whenever the A11 External Reference (Option –04) is installed. The field installation kit for the External Reference Option is identified as the 8200A–04K.

6-3. INSTALLATION

6-4. Use the following procedure to install the A11 External Reference Option in the 8200A DVM.

NOTE!

Rear Input (Option –05) must be installed before installation of the External Reference Option can be completed. Refer to Rear Input (Option –05) Section 6.

a. Disconnect power cord from line power.

b. Remove top outer and guard covers.

c. Remove A7 A to D Analog assembly from the 8200A.

d. Plug the A11 External Reference board connectors into the A7 A to D Analog board connectors. Pin 1 on A11 External Reference board mates with pin 1 on A7 A to D Analog board.

e. Check pins on A11 External Reference board to ensure they are correctly mated with receptacles on the A7 A to D Analog board.

f. Secure the A11 External Reference board to the A7 A to D Analog board with hardware provided.

g. Install the A7 A to D Analog board in the instrument.

h. Seat the HI and LO leads from the A11 External Reference board into the Rear Input connector, observing the decal on rear panel for proper pin placement.

NOTE!

When properly seated, the Rear Input connector pins will lock into place.

i. Attach guard and outer covers, connect ac power, and perform receiving inspection test of the External Reference Option as described in the Performance Test paragraphs of Section 4.

Option–05
Rear Input

6-1. INTRODUCTION

6-2. The Rear Input is installed as the –05 Option. It can be installed at the factory during manufacture or later in the field, as desired. The field installation kit for the Rear Input is identified as the 8200A–05K.

6-3. INSTALLATION

6-4. Use the following procedure to install the Rear Input Option in the 8200A DVM.

a. Disconnect power cord from line power.

b. Remove top and bottom outer and guard covers.

c. Remove A6 Logic Control and the A7 A/D Analog assemblies from the instrument, plus the following options (if installed): A8 RCU (–08 Option), A9 and A10 DOU (–07 Option), and A16 Printer (–06 Option).

d. Place Filter Assembly bracket between the rear bulkhead and rear panel. Secure bracket to the rear bulkhead with hardware provided.

NOTE!

Rear Input Connector must protrude through rear panel.

e. Dress the Rear Input cable through cable clamps on rear panel and through the left side of instrument, as viewed from the front panel. Tie cable along the outside portion of chassis. Then dress cable through the left side near the INPUT terminals.

f. Connect cable to INPUT terminals as follows:

WHITE – INPUT HI
BLACK – INPUT LO
BLUE – Mounted to spacer on the left rear portion of the A12 Display assembly.

g. Install all assemblies removed in step c.

h. Attach guard and outer covers, connect ac power, and perform receiving inspection test of the Rear Input Option.

PARTS LIST

DESCRIPTION	STOCK NO.	TOT QTY	REC QTY	USE CODE
MODEL 8200A - KIT REAR INPUT	8200A-05K			
Filter Assembly, 8200A-4022	329144	1		
Screw, 6-32 x 1/2	177030	3		

Option—06
Printer Output Unit

6-1. INTRODUCTION

6-2. The A16 Printer is installed as the –06 Option. It can be installed at the factory during manufacture or later in the field, as desired. When the A16 Printer (Option –06) is installed, the A9 and A10 Data Output (Option –07) cannot be installed. The field installation kit for the Printer is identified as the 8200A–06K.

6-3. INSTALLATION

6-4. Use the following procedure to install the A16 Printer Option in the 8200A DVM.

a. Disconnect power cord from line power.

b. Remove top outer and guard covers.

c. Determine that connector J9 on A13 Interconnect board, which mates with A16 Printer board, is clear of obstructions and that alignment spacers are inserted between the following pin pairs of J9:

3 and 4
17 and 18
8 and 9
22 and 23

NOTE!

A9 and A10 Data Output Unit No. 1 and 2 must be removed to install the A16 Printer Option.

d. Determine that the connector slot on rear panel for P18 on Printer board is clear of any obstructions.

e. Insert P18, on Printer board, into connector slot on rear panel.

f. Insert edge of Printer board into card guide on the inner chassis foreward bulkhead.

g. Observe that alignment spacers on J9 line up with slots on the Printer board card-edge connector (P16).

h. Slide board downward until the card-edge connector is fully engaged with J9.

i. Dress the shielded cable across the rear panel and toward the transformer.

j. Connect the shielded cable to J20 on transformer bracket as follows: Black lead connects to the terminal closest to the transformer; White lead connects to the terminal furthest away from transformer.

k. Attach guard and outer covers, connect ac power, and perform receiving inspection test of the Printer Option as described in Performance Test paragraphs in Section 4.

Option—07
Data Output Unit

6-1. INTRODUCTION

6-2. The A9 and A10 Data Output Unit No. 1 and 2 are installed as the –07 Option. This option can be installed at the factory during manufacture or later in the field, as desired. The field installation kit for the Data Output Unit Option is identified as the 8200A–07K.

6-3. INSTALLATION

6-4. The following procedure should be used to install the Data Output Unit in the Model 8200A.

a. Disconnect the power cord from line power.

b. Remove the top dust and guard chassis covers.

c. Determine that connector J9, on A13 Interconnect board, which mates with A9 DOU No. 1 board, is clear of obstructions and that alignment spacer is inserted between pin pairs J9-3 and -4 and J9-17 and -18. A second alignment spacer must be inserted between pin pairs J9-8 and -9 and J9-22 and -23.

d. Determine that connector J10 on A13 Interconnect board, which mates with A10 DOU No. 2 board, is clear of obstructions and that alignment spacer is inserted between pin pairs J10-4 and -5 and J10-10 and -11. A second alignment spacer must be inserted between pin pairs J10-5 and -6 and J10-11 and -12.

e. Determine that connector slots on rear panel for P14 and P15 on Data Output Unit boards are clear of any obstructions.

f. Insert P14 on A9 Data Output Unit No. 1 into connector slot on rear panel, while inserting P15 on A10 Data Output Unit No. 2 into rear panel connector slot. (Refer to Section 4, Figure 4-1 for physical location of A9 and A10)

g. Insert edge of both the Data Output Units (A9 and A10) into card guides on the inner chassis bulkhead.

h. Observe that alignment spacers on J9 and J10 line up with slots on the Data Output Unit card-edge connectors.

i. Slide both boards downward until card-edge connectors on A9 and A10 are fully engaged with J9 and J10 on A13 Interconnect board.

j. Lay the twisted pair cable under the top portion of the rear panel and route toward transformer.

k. Connect wires to jacks mounted on transformer bracket as follows: Black lead connects to terminal closest to the transformer; White lead connects to the terminal furthest away from the transformers.

l. Attach guard and dust covers, connect ac power, and perform receiving inspection test of the Data Output Units as described in Performance Test paragraphs of Section 4.

Option—08
Remote Control Unit

6-1. INTRODUCTION

6-2. The A8 Remote Control Unit is installed as the –08 Option. It can be installed at the factory during manufacture or later in the field as desired. The field installation kit for the Remote Control Unit is identified as the 8200A–08K.

6-3. INSTALLATION

6-4. Use the following procedure to install the A8 Remote Control Unit Option in the 8200A DVM.

a. Disconnect the power cord from the instrument.

b. Remove the top dust and guard chassis covers.

c. Determine that connector J8 on the A13 Interconnect board, which mates with A8 Remote Control board, is clear of obstructions and that alignment spacers are inserted between the following pin pairs of J8:

1 and 2
10 and 11
7 and 8

d. Determine that connector slot on rear panel for P13 on Remote Control Unit board is clear of any obstructions.

e. Insert P13 into connector slot on rear panel (refer to Section 4, Figure 4-1).

f. Insert edge of Remote Control Unit board into card guide on the inner chassis bulkhead.

g. Observe that alignment spacers on J8 line up with slots on the Remote Control Unit card-edge connector.

h. Slide pcb downward until the card-edge connector is fully engaged with J8 on A13 Interconnect board.

i. Attach top guard and chassis covers, connect ac power, and perform receiving inspection test of the Remote Control Unit as described in Performance Test paragraph in Section 4.

Option –09
True RMS Converter

6-1. INTRODUCTION

6-2. The Model 8200A can be used to perform true rms voltage measurements when equipped with Option –09. This option provides true rms measurement of a wide variety of waveforms. Measurements can be made from 1 mV to 1100 volts over a frequency range of 20Hz to 300kHz. In addition, either ac or dc input coupling can be selected by the operator.

6-3. SPECIFICATIONS

RANGES 1V, 10V, 100V, 1000V

Resolution . . . . . 0.01% of range, (100μv maximum on 1V range)

Overrange . . . . . 60%, (1100V rms maximum input on 1000V range)

Overload (without damage) . . . . . 1100V rms continuously applied at any range (1500V peak AC)

Superimposed DC . . . . . ±1100 VDC (Peak ac plus dc not to exceed ±1500V)

Crest Factor . . . . . 7 at full scale, increasing downrange per $7 \times \sqrt{\frac{\text{V RANGE}}{\text{V INPUT}}}$

ACCURACY (To 160% of range or 1100V maximum input)

		AC + DC	AC Only
90 days,	DC	±(0.1% of input + 0.04% of range)	
(18°C to 28°C)	50Hz-10kHz	±(0.2% of input + 0.04% of range)	±(0.1% of input + 0.02% of range)
(0.001V-1100V)(2)	10kHz-30kHz (1)	±(0.2% of input + 0.06% of range)	±(0.2% of input + 0.04% of range)
	30kHz-50kHz (1)	±(0.3% of input + 0.12% of range)	±(0.3% of input + 0.1% of range)
	20Hz-50Hz	±(0.5% of input + 0.04% of range)	±(0.5% of input + 0.02% of range)
	50kHz-100kHz (1)	±(1% of input + 0.3% of range)	±(1% of input + 0.3% of range)
	100kHz-300kHz (1)	±(2% of input + 0.5% of range)	±(2% of input + 0.5% of range)

(1) Input volt x hertz, product should not exceed 2×10^7

(2) With inputs above 500V multiply accuracy by $\frac{2000V + V\ input}{2000V}$

Temperature Coefficient (–10° to 18°C and 28°C to 50°C)

DC & 20Hz - 10kHz (AC + DC) . . . . . ±(0.004% of Input ±0.004% of range)

20Hz - 10kHz (AC only) . . . . . ±(0.004% of 0.001% of range)

Input Impedance . . . . . 1.0 megohm, shunted by less than 130 p.f.

NOISE REJECTION

Common Mode (With up to 100Ω unbalance in either lead)

DC to 60Hz . . . . . Greater than 120 db

SETTLING TIME . . . . . Less than 500 milliseconds to within 0.1% for reading greater than 10% of range. (For readings less than 10% range, double indicated times.)

6-4. KIT INSTALLATION

6-5. The following paragraphs describe the installation of true rms converters received as kits. Installation procedures vary depending upon the serial number (S/N) of the Model 8200A.

6-6. Kit Contents

6-7. All or some of the parts received in the kit will be used depending upon the installation procedure followed. The True RMS Converter Kit contains one each of the following items:

True RMS Converter PCB Assembly
Top Guard Cover
Pin Connector, Male
Bus Wire
Teflon sleeving
"FILT/RMS–DC" Decal

6-8. Model 8200A S/N 123 through 1334

6-9. Instruments in this serial number range may require some modification to the Model 8200A mainframe, depending upon the type of input coupling desired. If only ac coupling is required, no modifications will be necessary. However, if ac and dc (ac/dc) coupling are required, some minor modifications will be necessary.

6-10. AC COUPLING

a. With 8200A disconnected from power source, remove top dust cover and inner guard cover.

b. Locate A5 assembly position. Remove any existing assembly in that position.

c. Remove blue wire from True RMS Converter Assembly and install assembly in A5 position.

d. Connect red and black leads to rear of respective HI and LO INPUT terminals.

e. Install new guard cover and original dust cover.

6-11. AC/DC COUPLING

a. With 8200A disconnected from power source, remove both top and bottom dust and guard covers. (While removing top guard cover, note location of A4 and A5 positions.)

b. Remove A4 assembly without disconnecting associated wiring at INPUT terminals.

c. Remove A5 assembly, if previously installed, including associated wiring at rear of INPUT terminals.

d. Solder male pin connector in location indicated in Figure 6-1. Clean area thoroughly with alcohol, removing all flux. Bend pin connector at 45° angle towards A5 position.

e. Insert True RMS Converter PCB Assembly in A5 position and connect blue wire to previously installed pin connector.

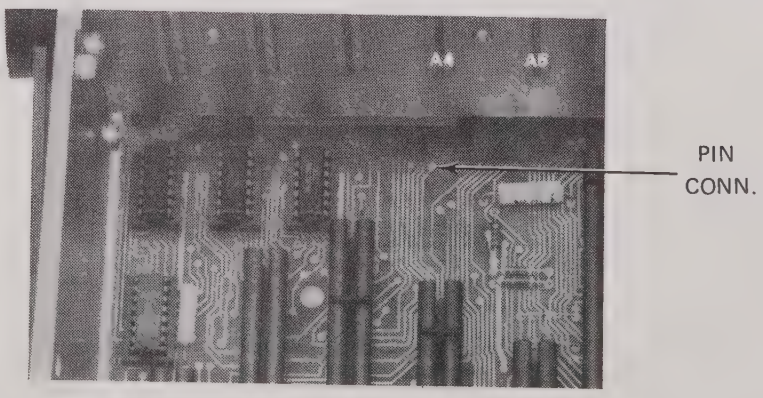


Figure 6-1. PIN CONNECTOR LOCATION

f. Install A4 assembly.

g. Connect red and black wires from True RMS Converter Assembly to rear connectors of respective HI and LO INPUT terminals on front panel.

NOTE!

For instruments containing the RCU (Option –08), remove A8CR14. This allows remote programming of the input coupling to the RMS Converter. When the FILT/RMS–DC is called on pin 26 (P13-26, RCU Rear Panel Connector) during the VAC function, the input coupling to the converter will be direct (ac + dc).

h. Install top guard cover, supplied with kit, and top dust cover.

i. Turn instrument upside down with front panel towards you.

j. Solder sleeved bus wire between points indicated in Figure 6-2. Clean area thoroughly with alcohol, removing all flux.

k. Install bottom guard and dust covers.

l. Place "FILT/RMS–DC" decal over "FILTER" on front panel.

j. Modification and installation are complete.

NOTE!

In the VAC function, the FILT/RMS –DC pushbutton allows selection of either ac coupling (button out) or direct coupling (button in). In all other instrument functions, the pushbutton actuates the filter.

6-12. Model 8200A, Any 5 or 6 Digit Serial No.

a. With 8200A disconnected from power source, remove top dust cover and inner guard cover.

b. Locate A5 assembly position. Remove any existing assembly in that position, including associated wiring at rear of INPUT terminals.

c. Remove A4 assembly without disconnecting associated wiring at rear of INPUT terminals.

d. Insert True RMS Converter Assembly in A5 position. Connect blue wire to male pin connector (bent at 45° angle) near front bulkhead in A4 location. Refer to Figure 6-1 for pin location.

e. Connect red and black leads to rear of respective HI and LO INPUT terminals.

NOTE!

For instruments containing the RCU (Option –08), remove A8CR14. This allows remote programming of the input coupling to the rms converter. When the FILT/RMS–DC is called on pin 26 (P13-26, RCU Rear Panel Connector) during the VAC function, input coupling to the converter will be direct (ac + dc).

f. Install guard and dust covers.

g. Kit installation is complete.

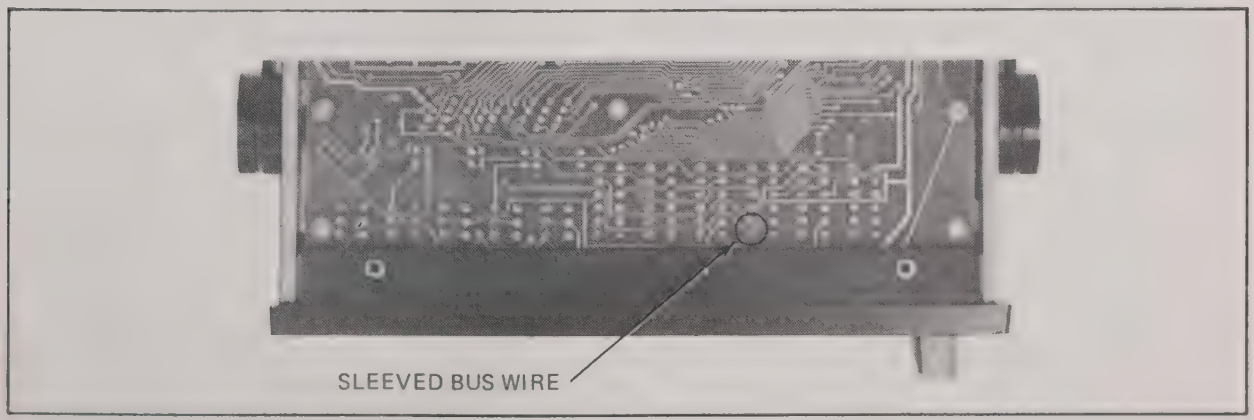


Figure 6-2. BUS WIRE LOCATION

NOTE!

In the VAC function, the FILT/RMS–DC pushbutton allows selection of either ac coupling (button out) or direct coupling (button in). In all other instrument functions, the pushbutton actuates the filter.

6-13. OPERATION

6-14. The Model 8200A equipped with a True RMS Converter is operated like an 8200A equipped with the average responding AC Converter. However, the readout displayed will be the true rms value of the waveforms being measured. In addition, the choice of input coupling allows measurement of either the ac component (FILT/RMS–DC pushbutton out)or ac plus dc components (FILT/RMS–DC pushbutton in).

6-15. THEORY OF OPERATION

6-16. General Description

6-17. The True RMS Converter provides a dc voltage, proportional to the true rms value of the applied INPUT voltage, to the A/D Converter for digitizing and subsequent display on the front panel readout. A simplified diagram of the circuits involved in the rms conversion process is illustrated in Figure 6-3. As shown in the diagram, the RMS Converter consists, basically, of a Range Amplifier and RMS Detector. Output voltage from the Range Amplifier is 1 volt rms ac, maximum, for a full scale INPUT voltage. A scaled output voltage from the Range Amplifier is applied to the RMS Detector's Balance Amplifier which produces a positive halfwave rectified output signal. The output of the Balance Amplifier is summed with the output of the Range Amplifier at the summing junction of the Squaring Amplifier. This provides a rectified version of the Range Amplifier output. The rectified signal is processed by the Squaring Amplifier, Integrating Amplifier, and Square Root Amplifier, respectively. These three amplifiers perform squaring, integrating, and square rooting functions which result in a dc voltage proportional to the rms value of the INPUT voltage.

6-18. Circuit Description

6-19. RANGE AMPLIFIER

6-20. The Range Amplifier scales the applied input voltage to the Converter to 1 volt rms ac for a full scale input. Basically, the Range Amplifier is an inverting operational amplifier whose gain changes as the range changes. Voltage gains of −1, −10, −100, and −1000 correspond with the 1 through 1000 volt ranges, respectively. Active elements of the Range Amplifiers are Q2, Q3, Q11, and U2 with protection diodes CR1, CR2, CR16, CR17, CR12, and CR15. Transistor Q2 drives the guard at the summing point of the operational amplifier, and Q11 switches C9 into feedback path in the 10, 100, and 1000 volt ranges. Diodes CR1, CR2, CR16, and CR17 provide clipping for input overload protection to Q3. Diodes CR12 and CR15 provide overload clipping at the output of the Range Amplifier for protection of the following circuitry.

6-21. BALANCE AMPLIFIER

6-22. The Balance Amplifier is a rectifying amplifier with a gain of −1 that changes all negative going signals from the Range Amplifier output to positive voltages prior to summing with the Range Amplifier output from R34. Balance Gain adjustment (R36) controls the input to the Balance Amplifier, such that resultant positive signals at the summing junction of R34, R35 will be equal in magnitude. Active components of the Balance Amplifier are Q4, Q5, Q6, and U3. Balance Zero Adjustment, R25, is an adjustment for zeroing the input of U3. Primary or low frequency signal path is through U3 followed by CR8 and final output stage Q6. At frequencies above a few hundred kilohertz, amplification takes place through Q4 followed by Q6. The final output stage, Q6, has a current source load, CL1, which maintains a high amplifier output impedance for driving CR9 and CR10. Any stray capacitance in CR9 and CR10 is compensated by Q5. Transistor Q5 samples the waveform driving CR9 and CR10 and feeds back a capacitive charge through C15 to the input of the Balance Amplifier.

6-23. SQUARING AMPLIFIER

6-24. The Squaring Amplifier is an inverting operational amplifier with non-linear feedback through matched transistors Q8A and Q9B. These transistors transform the input current into an output voltage that is the log of the input current. Since this operation is performed twice (by Q8A and Q9B), the output voltage is twice the log of the input current. Therefore, the amplifier essentially accomplishes a squaring operation. U4 is an integrated operational amplifier which is paralleled by Q7 at high frequencies in a manner similar to Q4 in the Balance Amplifier. AC ZERO Adjustment, R40, provides for zeroing of U4, and has the greatest effect, of all other zero adjusts,

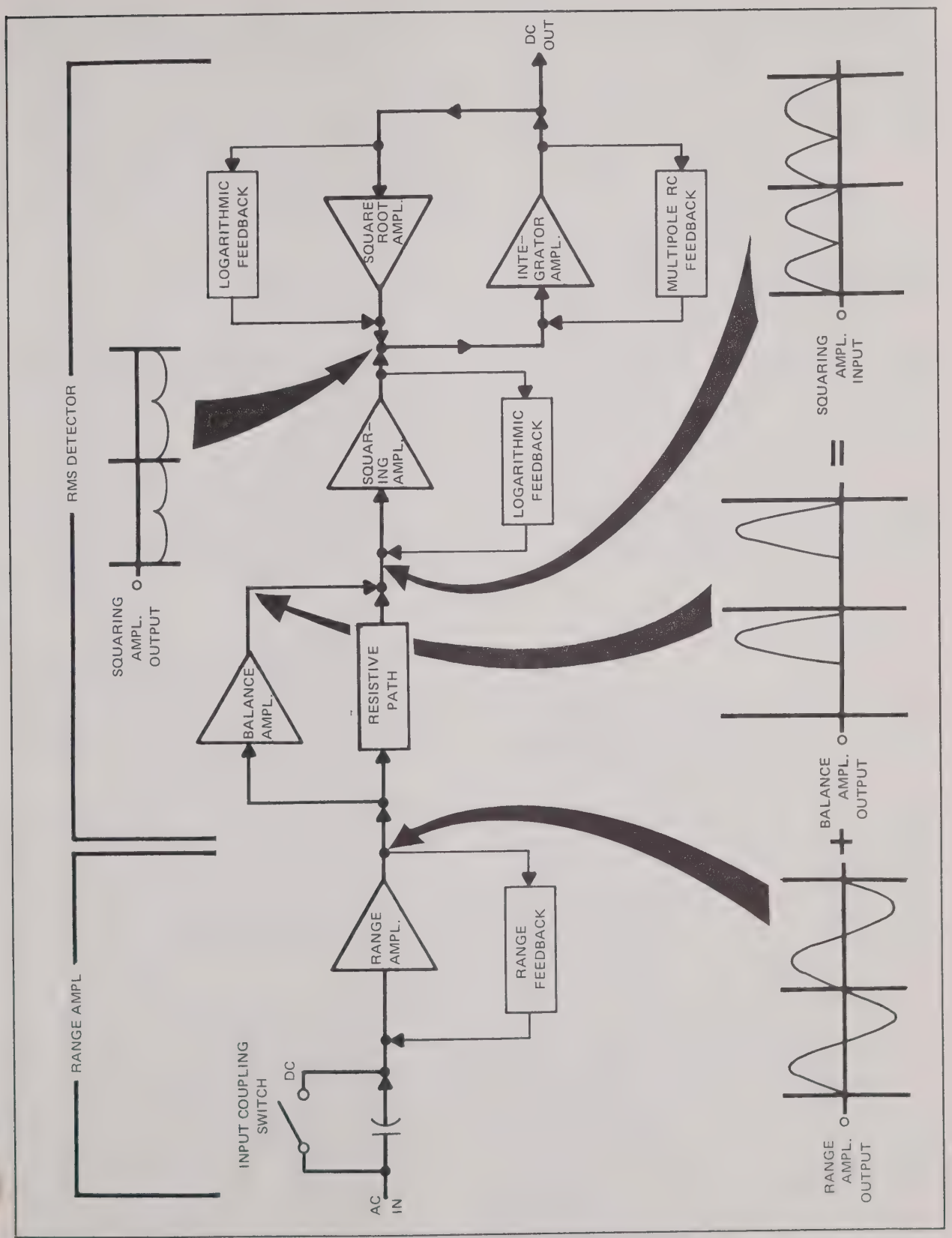


Figure 6-3. TRUE RMS CONVERTER BLOCK DIAGRAM

for overall converter zero. Both amplifying paths, U4 and Q7, share the common final output stage, Q10. Output voltage from Q10 is sampled by Q9A which provides a current to the summing point of the Integrator Amplifier. Potentiometer R43 provides an adjustment for crest factor gain.

6-25. INTEGRATOR AMPLIFIER

6-26. The Integrator Amplifier consists primarily of U5 and U7, and is a complex multipole integrator which acts as a three pole filter. Voltage at terminal 2 of U5 is held at zero, and all of the current applied is passed through the feedback elements R52, C24 and C21. Amplifier U5 and associated multipole feedback circuitry provides the integration for the Integrator Amplifier. Amplifier U7 is a unity gain, high input impedance, low output impedance amplifier. The three poles of feedback consists of C21, R71 and C12, and R72 and C28. Output from U7 is the output of the total Integrator Amplifier which is applied to the Square Root amplifier. The output of the Integrator is also applied to the A to D Converter via the 5:1 resistive divider including R70 and R61 and the additional filter capacitor C29.

6-27. SQUARE ROOT AMPLIFIER

6-28. The Square Root Amplifier consists of the input resistor R56, the trimming and selection resistors R60, R62, R63, and R74, the feedback transistor Q8B, protection diode CR13, and the amplifier U6. Diode CR13 acts as a feedback path to prevent saturation of U6 should input polarity to the amplifier reverse. The Square Root Amplifier uses logarithmetric feedback to produce a square root of the input in a manner similar to that used by the Squaring Amplifier. The square root process is accomplished by matched transistors Q8B and Q9A. Resistors R76, R77, and R45 are factory selected for overall converter temperature coefficient and linearity. Some or none of these resistors may be installed.

6-29. MAINTENANCE

6-30. Maintenance information, described in the following paragraphs, is specifically intended for the True RMS Converter Assembly. Factory service information and general instructions regarding instrument access and cleaning are described in Section 4 of the Instruction Manual.

6-31. Test equipment for calibrating and troubleshooting the True RMS Converter is listed in Table 6-1. If the recommended equipment is not available, equipment having at least equivalent specifications may be used.

6-32. Calibration

6-33. The True RMS Converter should be calibrated every 90 days, or whenever repairs have been made to circuitry. Calibration of the converter should be performed at an ambient room temperature of 23°C ±5°C. Relative humidity should be less than 70%.

Table 6-1. TEST EQUIPMENT

NOMENCLATURE	REQUIRED SPECIFICATIONS	RECOMMENDED EQUIPMENT
AC Voltage Source	1mV and 1000V @ 500Hz, 1V 10V, 100V @ 500Hz and 50kHz ±0.03% and 1000V @ 50kHz ±0.3%	Fluke Model 5200A AC Calibrator and 5205A Power Amplifier
DC Voltage Source	10V ±0.01%	Fluke Model 341A DVM Calibrator
DC Differential Voltmeter	100μV Range, ±0.005%	Fluke Model 895A Differential Voltmeter
RMS Differential Voltmeter	100Hz @ ±0.05% Crest Factor of 10	Fluke Model 931A True RMS Differential Voltmeter
Oscilloscope	General Purpose	Tektronix 544 W/Type L Plug-In and Low Capacitance Probe
Pulse Generator	50Ω Source Impedance, 5V max. across 50Ω, (+) and (–) pulse polarity, Rise and Fall Time < 50ns	HP 8003A Pulse Generator

6-34. PRELIMINARY OPERATIONS

a. Remove top dust cover.

b. Set rear panel 115/230 volt switch to 115 volt position. Connect line cord to autotransformer set to 120 volts ac.

c. Turn instrument on and allow to "warm-up" for 10 minutes.

6-35. RANGE AMPLIFIER ZERO

a. Short HI and LO INPUT terminals. Select VAC, RMS–DC, and 10 RANGE pushbuttons.

NOTE!

For Option –09's without dc coupling, connect jumper wire across input coupling capacitor C1.

b. Connect high lead of external dc voltmeter to body of C4 (10V 50kHz adjustment) via a 10k isolation resistor, Connect low lead to LO INPUT terminal.

c. Adjust R66 (Range Zero Adjust) for external voltmeter indication of 0 $\pm 30\mu V$.

d. Remove external voltmeter and INPUT short.

6-36. BALANCE AMPLIFIER ZERO

a. Apply –0.1V dc to INPUT terminals from dc voltage source. Note 8200A reading.

b. Reverse input voltage polarity to +0.1V dc.

c. Adjust R25 (Balance Zero Adjust) for reading noted in step a.

d. Repeat steps a and b until difference between readings for each polarity is within 1 digit.

6-37. BALANCE GAIN

a. Apply –10V dc to INPUT terminals. Note 8200A reading.

b. Reverse input voltage polarity to +10V dc.

c. Adjust R36 (Balance Gain Adjust) for an 8200A reading equivalent to step a.

d. Repeat steps a through c until difference between readings for each polarity is within 1 digit.

e. Remove dc voltage source.

6-38. AC ZERO

a. Select 1 RANGE and ac coupling (FILT/RMS–DC pushbutton out). Apply 0.001 volts at 500Hz to INPUT terminals.

b. Adjust R40 (AC Zero Adjust) for reading of .0010 $\pm <$ 1 digit (may occasionally read .0009 or .0011).

c. Remove ac input voltage.

6-39. CALIBRATION ADJUSTMENT/CHECK

6-40. Before performing calibration, allow one hour "warm-up" with outer cover installed. Refer to Table 6-2; apply each of the rms voltages at the specified frequencies to the INPUT terminals and, if necessary, perform the indicated adjustments to complete the calibration. If R60 (1000V, 500Hz adjustment) is not within adjustment range, refer to paragraph titled "Course Calibration."

Table 6-2. CALIBRATION ADJUSTMENT/CHECK

INPUT		RANGE	ADJUSTMENT		TOLERANCE
VOLTAGE (RMS VOLTS)	FREQUENCY		NAME	REF DESIG.	
500.0	500Hz	1000	1000 VAC 500Hz	R60	
500.0	50kHz	1000	1kVAC 50kHz	C2	
1.0000	500Hz	1	1 VAC 500Hz	R15	
1.0000	50kHz	1	1 VAC 50kHz	C11	±1 Digit
10.000	500Hz	10	10 VAC 500Hz	R16	
10.000	50kHz	10	10 VAC 50kHz	C4	
100.00	500Hz	100	100 VAC 500Hz	R17	
100.00	50kHz	100	100 VAC 50kHz	C13	

6-41. COURSE CALIBRATION

6-42. Use the following procedure only when R60 is out of adjustment range.

a. Connect any opened shorting links (1, 2, or 3) across course calibration resistors R62, R63, or R74.

b. Select the 1000 volt range and apply 500V @ 500Hz to the INPUT terminals.

c. Adjust the "1000V 500Hz" control (R60) for a minimum reading.

d. Cut open the appropriate link or links as indicated below depending upon the 8200A reading.

READING	CUT LINKS
480.0 – 485.0	3
485.0 – 490.0	3, 1
490.0 – 495.0	3, 2
495.0 – 500.0	NONE
500.0 – 505.0	1
505.0 – 510.0	2
510.0 – 515.0	1, 2

e. Repeat the "Calibration Adjustment/Check" paragraph to complete calibration.

6-43. Troubleshooting

6-44. The troubleshooting procedure presents a technique for isolating a malfunction to one of the five amplifier circuits within the RMS Converter. This procedure is found on the page opposite the schematic diagram (8200A-1028). Before using the procedure, ensure that the malfunction is within the RMS Converter and not due to operator error, faulty test leads, etc.

6-45. PRE-CALIBRATION ADJUSTMENTS

6-46. Three adjustments within the RMS Converter are not readjusted during routine calibration. These adjustments are the Square Root Zero, Integrator Zero, and Crest Factor. It is recommended that these three adjustments be attempted only if previously moved or if components are replaced within the converter. Procedure for performing these adjustments is as follows:

a. With power off, extend the RMS Converter from the 8200A mainframe and remove shield from converter. Turn on power and allow instrument 10 minutes to stabilize.

b. Short INPUT terminals. Short TP1 and TP2 to common (shield). Connect dc voltmeter (Table 6-1) between TP4 (+) and common (–).

c. Adjust R50, Integrator Zero Adjust, for 0 volts ±30 microvolts.

d. Remove short from TP2 and connect dc voltmeter (+) lead to TP2.

e. Adjust R51, Square Root Zero, for 0 volts ±200 millivolts.

f. Remove short from TP1 and disconnect dc voltmeter.

g. Complete Preliminary Operations of calibration procedure starting with paragraph 6-33 through 6-38.

h. Connect equipment as diagramed in Figure 6-4. Set Model 8200A to ac coupling and auto range.

NOTE!

The following adjustment procedure is for crest factor. Crest factor (cf) is the relationship between the peak and rms value, such that cf = VPeak/VRMS.

i. Adjust generator repetition rate for 100 pulses per second (10 msec) and pulse width for a maximum indication on Model 931. (This will be a symmetrical waveform.)

j. Adjust generator negative output amplitude control for 1 volt RMS indication on 931. This establishes a waveform with crest factor of 1. Note Model 8200A reading.

k. Adjust generator amplitude control for 4 volts peak to peak indication on scope and pulse width control for 1 volt RMS indication on Model 931. This establishes a waveform with crest factor of 4.

l. Adjust R43 (Crest factor Adjust) for Model 8200A indication noted in step j.

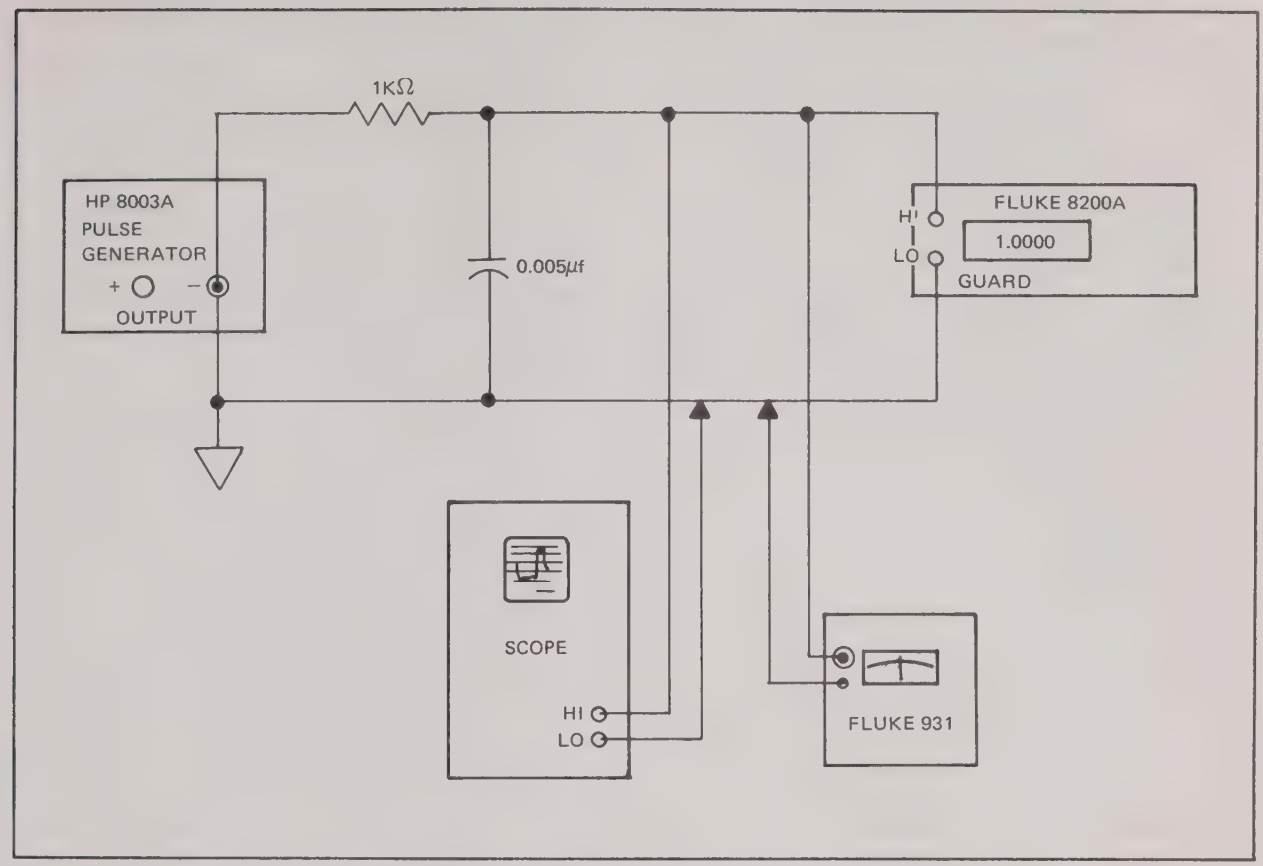


Figure 6-4. EQUIPMENT CONNECTIONS FOR CREST FACTOR ADJUST

m. Repeat steps j through l until difference between readings for crest factors of 1 and 4 is less than 1 digit.

n. Check positive polarity pulse with crest factor of 4 by connecting equipment to pulse generator positive output and make adjustments described in step k.

o. 8200A indication should be within 3 digits of finalized value noted in step j.

p. Turn power off. Disconnect all test equipment from 8200A. Re-install shield on RMS Converter and install converter in 8200A mainframe. Install top guard and dust cover. Turn on instrument and allow to "warm-up" for one hour before performing Calibration Adjustment/Check, paragraph 6-39.

6-47. MATCHED COMPONENTS

6-48. A few components within the RMS Converter are matched at the factory. Two transistors, Q8 and Q9, are matched to each other. Resistors R45, R76, and R77 are factory selected for overall converter temperature coefficient and linearity which also affects Q8 and Q9. Should any of these components require replacement, a complete matched set will have to be ordered. In the case of replacement, the total set must be installed. Depending upon the matched set received, some or none of the three resistors may be included. Therefore, in positions where there is no resistor to install, a bus wire must be installed. Refer to List of Replaceable Parts for ordering information.

Accessory

POU, DOU, RCU Mating Connector

6-1. INTRODUCTION

6-2. The mating connector shown in Figure 6-1 is required for interface between the Remote Control Unit and the programming equipment. It also provides interface between Data Output Unit No. 1 & 2 of Printer assembly and external equipment. This connector is obtained when either option is ordered, or can be obtained by ordering from the factory by referencing FLUKE PART NO. 321646.

6-3. ASSEMBLY INSTRUCTIONS

6-4. Wiring and assembly of the mating connector is done as follows:

a. Solder the wiring to the appropriate terminals of the connector. Refer to Figure 6-1, Detail I for terminal locations. Functional pin assignments for the Remote Control Unit, the Printer assembly, and the Data Output Unit No. 1 and 2 can be found in Section 2.

b. Mount alignment spacers (F) between proper pins on Connector (B). Spacer positions are as follows:

RCU Connector	– pin position 23 and 24
DOU No. 1 Conn.	– pin position 11 and 12
DOU No. 2 Conn.	– pin position 21 and 22
Printer	– pin position 17 and 18

c. Mount Connector (B) into Backshell half (C). Refer to Detail II of Figure 6-1.

d. Mount Backshell half (A) onto Backshell half (C). When correctly mounted together the Backshell halves snap in place.

e. Secure Backshell (A) and (C) together with 4 screws (D), supplied.

f. Secure Connector (B) to Backshell (A) and (C) with two screws (E), supplied.

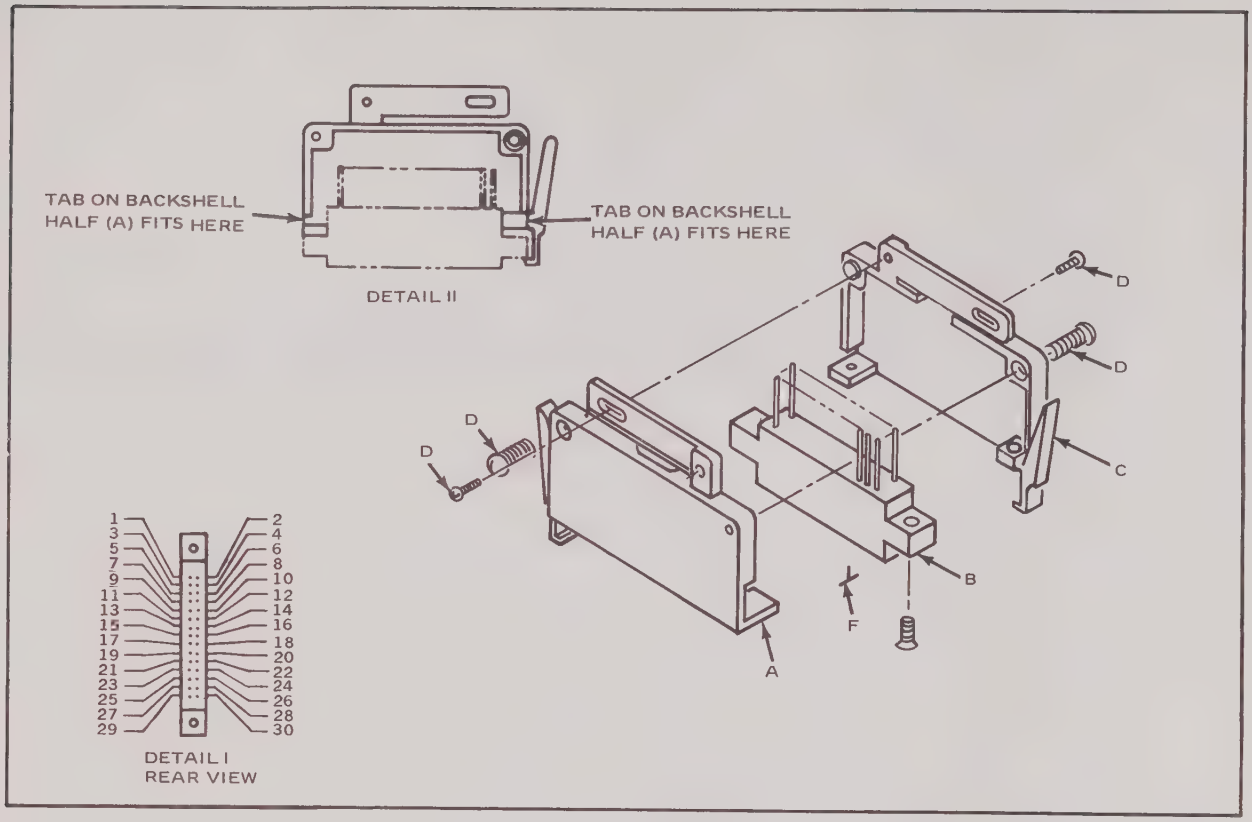


Figure 6-1. POU, DOU, RCU MATING CONNECTOR

Accessory

Rear Input Mating Connector

6-1. INTRODUCTION

6-2. The mating connector shown in Figure 6-1 is required for interface between the Rear Input connector and the external equipment. This connector is obtained when either option is ordered, or can be obtained by ordering from the factory by referencing FLUKE PART NO. 321653.

6-3. ASSEMBLY INSTRUCTIONS

6-4. Wiring and assembly of the mating connector is done as follows:

a. Solder the wiring to Terminals (B).

b. Insert Terminals (B) in Connector (A). Refer to Figure 6-1 for terminal locations and pin connections from External Reference Assembly to Connector.

c. Mount Cable Clamps (C) in Connector (A) and secure with hardware (D) to Connector (A).

d. Secure both parts of Cable Clamp (C) together with screws (E).

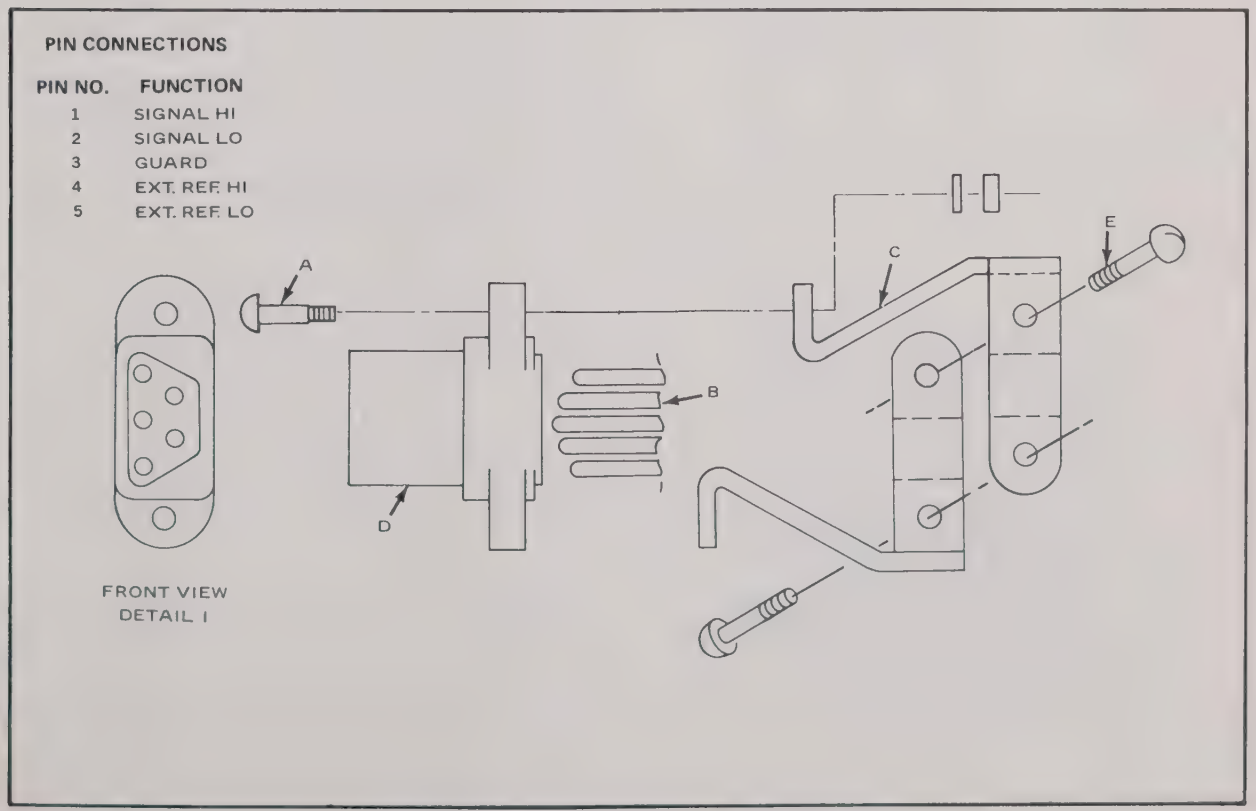


Figure 6-1. REAR INPUT MATING CONNECTOR

Accessory

Extender Card

6-1. INTRODUCTION

6-2. The Extender Card shown in Figure 6-1 is available as an Accessory for the FLUKE 8200A digital voltmeter. This accessory permits the printed circuit boards in the 8200A to be extended for servicing. The Extender Card can be obtained by referencing FLUKE PART NO. 292029.

6-3. INSTALLATION

6-4. To install a printed circuit board on the Extender Card proceed as follows:

a. Disconnect 8200A from line power.

b. Remove top dust and guard covers from instrument.

c. Locate the printed circuit board to be serviced and remove it from the instrument.

d. Install the Extender Card into the connector vacated by the removal of the printed circuit board.

e. Install the printed circuit board in the connector on the Extender Card. The printed circuit board must face the same direction as it did when installed into the instrument.

f. Connect 8200A to line power and turn on instrument. The printed circuit board can now be serviced.

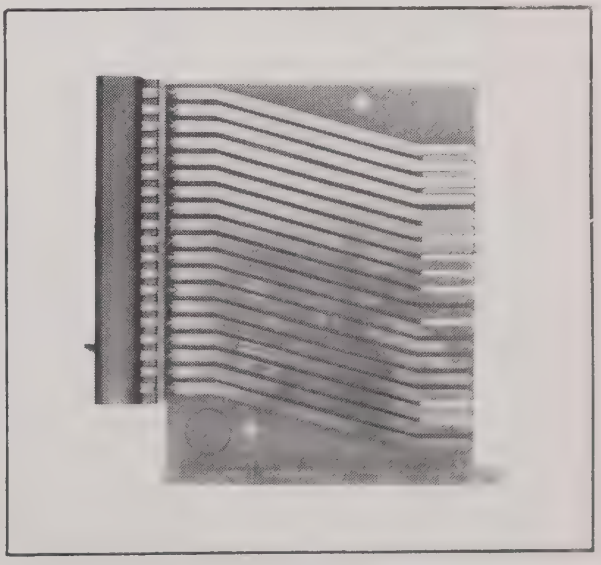


Figure 6-1. EXTENDER CARD

Accessory

Rack Mounting Fixture

6-1. INTRODUCTION

6-2. FLUKE half-rack instruments can be mounted in standard 19 inch equipment racks. A single instrument can be rack mounted with either a left or right offset. Offset mounting kit number is:

OFFSET KIT	M03-200-607

6-3. INSTALLATION

6-4. Procedure for installation of offset rack mounting kits is provided with the kit. The illustration is identified with a form number in the lower left hand corner. This form number is related to the kit number as follows:

FORM NO.	RACK KIT	CONFIGURATION
A409	M03-200-607	OFFSET

ACCESSORY INFORMATION

MODEL 80K-40 HIGH VOLTAGE PROBE

6-1. HIGH VOLTAGE PROBE (80K40)

6-2. Introduction

6-3. The Model 80K-40 High Voltage Probe as shown in Figure 6-1, provides the 1000X attenuation necessary to extend the dc voltage measuring capabilities of the 8200A up to 40 kV dc. A schematic of the 80K-40 probe is shown in Figure 6-2.

6-4. Specifications

Overall Accuracy:	20kV to 30kV ±2% (Calibrated 1% at 25kV).
Upper Limit:	Changes linear from 2% at 30kV to 4% at 40 kV.
Lower Limit:	Changes linear from 2% at 20kV to 4% at 1kV.
Voltage Range:	1 kV to 40kV
Input Resistance:	1000MΩ
Division Ratio:	1000:1

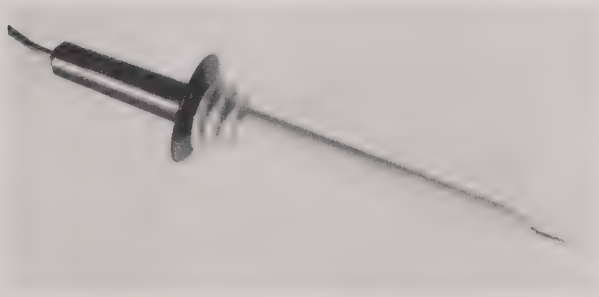


Figure 6-1. HIGH VOLTAGE PROBE (80K-40)

6-5. Operation

6-6. Use the following procedure for operating the 8200A with the 80K-40 probe:

a. Plug the 80K-40 dual-banana plug into the HI and LO terminals on the 8200A'

b. Depress the VDC pushbutton (FUNCTION).

c. Select the desired voltage range in accordance with Table 6-1.

d. Connect the common probe lead to a suitable ground and touch the probe tip to the circuit point to be measured.

e. Observe dc voltage reading displayed in kilovolts on the 8200A readout.

CAUTION

Before touching probe tip to a high voltage source, always connect probe common lead to circuit common. Removal of the probe common connection during a measurment may result in damage to the 8200A.

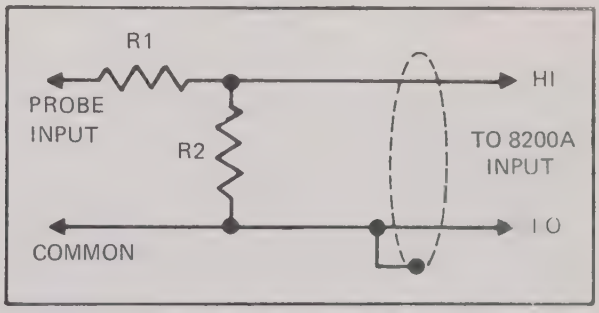


Figure 6-2. HIGH VOLTAGE PROBE, SCHEMATIC

Table 6-1. 8200A RANGES FOR DC HV PROBE (80K-40).

8200A RANGE SELECTED	8200A VOLTAGE RANGE WITH 80K-40 PROBE
100	10 to 40 kV
10	1 to 10 kV

NOTE: Probe is calibrated into 10MΩ so use of near infinite impedance 1 volt range will give approximately 9% higher reading than 10 volt range.

ACCESSORY INFORMATION

MODEL 81RF HIGH FREQUENCY PROBE

6-1. HIGH FREQUENCY PROBE (82RF)

6-2. Introduction

6-3. The Model 81RF High Frequency Probe Figure 6-1, extends the frequency range of the 8200A to include 100 kHz to 100 MHz for ac voltage measurements from 0.25 5o 30V rms. The 81RF operates in conjunction with the dc voltage ranges, and is connected to the 8200A using a shielded dual-banana plug and an adapter.

6-4. Specifications

Transfer Accuracy:	±1 dB from 100 kHz to 100 MHz.
Voltage Range:	.25V rms to 30V rms (operated into a 10 MΩ input resistance voltmeter). Peak responding calibrated to read rms value of a sinewave.
Maximum DC Input:	350V
Input Impedance:	12MΩ shunted by ≈ 15 pf maximum.

6-5. Operation

6-6. Use the following procedure for operating the 8200A with the 81RF probe:

a. Connect the 81RF shielded dual-banana plug to the 8200A HI and LO input terminals.

b. Attach the desired probe tip to the probe body.

c. Depress the VDC pushbutton (FUNCTION).

d. Select the 10 VDC range.

e. Connect the probe's ground lead to a suitable ground.

f. Touch the probe tip to the circuit point to be measured.

g. Observe the voltage reading displayed in volts rms on the 8200A readout.

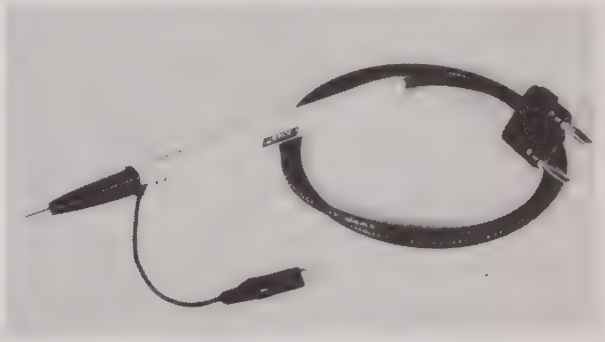


Figure 6-1. HIGH FREQUENCY PROBE (81RF)

ACCESSORY INFORMATION

MODEL 80F-15 VOLTAGE DIVIDER

6-1. INTRODUCTION

6-2. The Accessory Model 80F-15 Voltage Divider allows measurement of up to 15k volts dc to be made using FLUKE 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

6-3. Physical design of the Model 80F-15 allows direct mating to the input terminals of the FLUKE voltmeters. A high voltage probe facilitates connection to the measurement

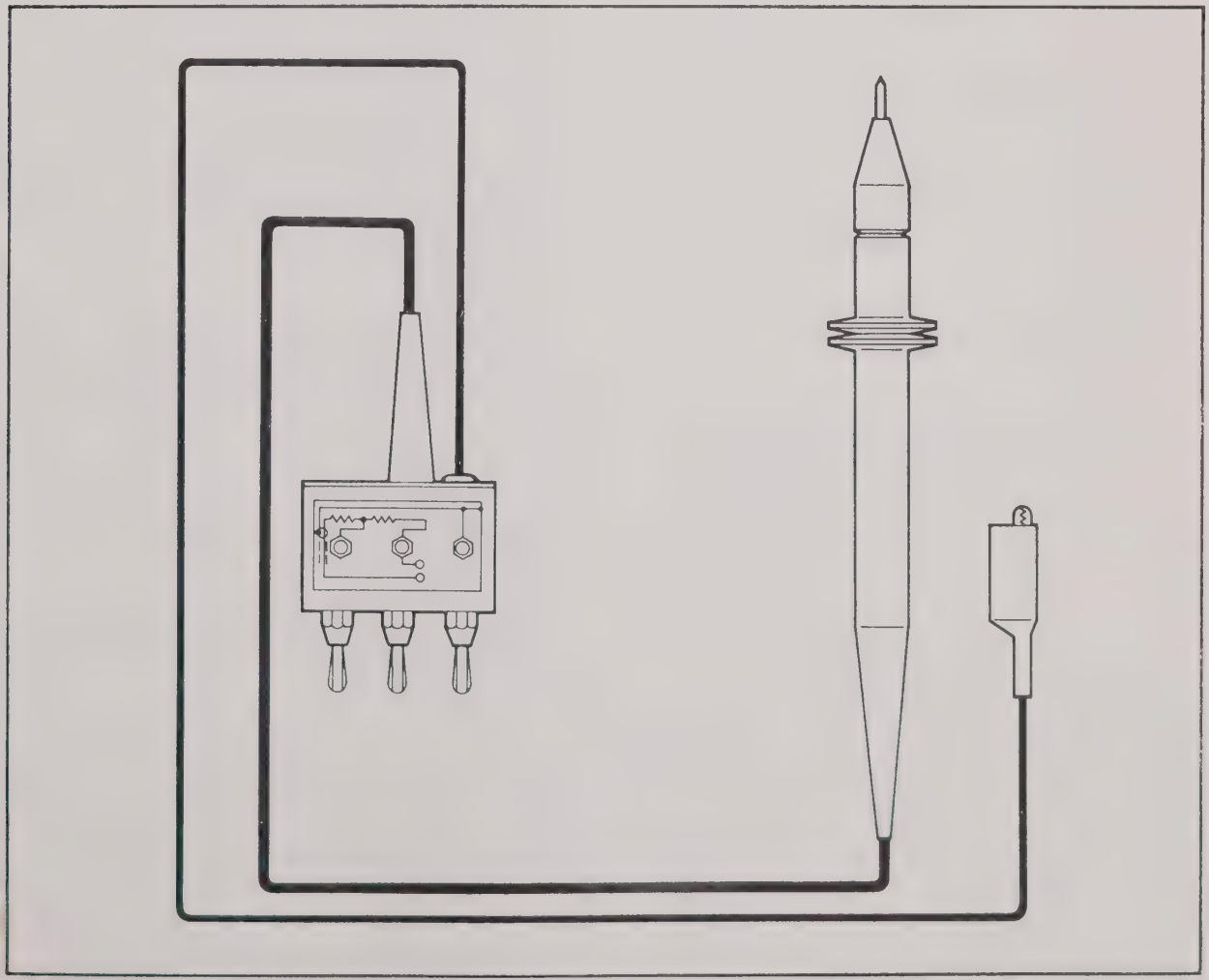


Figure 6-1. MODEL 80F-15 VOLTAGE DIVIDER

source. Maintenance is minimized by encapsulation of the divider components.

6-4. Three versions of the Model 80F-15 are available. The basic Model 80F-15 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance (10^3 megohm or greater) at null.

6-5. SPECIFICATIONS

6-6. Electrical

DIVISION RATIO:
1000:1

RATIO ACCURACY:
±0.01% of input from 1,000 to 15,000 vdc.

RATIO ACCURACY STABILITY:
±0.01% per month
±0.05% per year
} Calibrated by internal adjustment

VOLTAGE COEFFICIENT:
Less than 20 ppm total from 0 to 15,000 vdc.

TEMPERATURE COEFFICIENT:
0.001%/°C

INPUT RESISTANCE:
100 Megohms

MAXIMUM INPUT VOLTAGE:
15,000 vdc

REQUIRED VOLTMETER INPUT RESISTANCE:

80F-15	80F-15 (01)	80F-15 (02)
10 Megohms	11 Megohms	Infinite at null (10^3 megohms at greater)

MAXIMUM OUTPUT VOLTAGE:
15 vdc

6-7. Environmental

OPERATING:
Temperature Range – 0°C to 50°C
Humidity – 0 to 80%
Altitude Range – 0 to 10,000 feet

NON-OPERATING:
Altitude Range – 0 to 50,000 feet

6-8. Mechanical

WEIGHT:
24 ounces (680 grams)

DIMENSIONS:
2.725 inches high x 2.69 inches wide x 1.525 inches deep.

6-9. OPERATING INSTRUCTIONS

a. Connect the Model 80F-15 output terminals directly to the INPUT of the FLUKE voltmeter.

b. Select the appropriate dc voltage range on the FLUKE voltmeter.

c. Deenergize the high voltage source to be measured.

d. Connect the ground clip (–) and probe (+) to respective low and high sections of the high voltage source.

WARNING!

Lethal voltages will be present between the ground clip and probe of the 80F-15 when the high voltage source is energized.

e. Energize the high voltage source. Multiply the FLUKE voltmeter indication by 1000 to obtain the magnitude of the high voltage.

6-10. MAINTENANCE

6-11. General

6-12. The Model 80F-15 requires a minimum amount of maintenance. All that is required is occassional cleaning and calibration.

6-13. Cleaning

6-14. Accumulation of dust or dirt particles between the output terminals of the Model 80F-15 can be removed using clean dry pressurized air. Stubborn particles can be removed following an application of isopropyl alcohol.

6-15. Calibration

6-16. The Model 80F-15 division ratio should be checked every month or every year depending on the accuracy requirement. Ratio accuracy stability is specified at ±0.01% per month and ±0.05% per year. Calibration should be accomplished only after the Model 80F-15 has been in the non-operating state for at least four hours at a temperature of 23°C.

6-17. Test equipment requirements are a stable 1000 volt dc source such as the FLUKE Model 332B Voltage Calibrator and the FLUKE voltmeter. To calibrate the Model 80F-15, perform the following steps:

NOTE

The input resistance of the voltmeter must match that of the 80F-15. See paragraph 6-6, REQUIRED VOLTMETER INPUT RESISTANCE.

a. Calibrate the FLUKE voltmeter.

b. Install the Model 80F-15 on the FLUKE voltmeter input terminals.

c. Unscrew the strain relief on the input cable of the Model 80F-15 and remove the front cover.

d. Select the appropriate dc voltage range on the FLUKE voltmeter.

e. Apply 1000 volts dc to the Model 80F-15 high voltage probe.

f. Adjust the variable resistor on the Model 80F-15 for a 1.0 volt dc indication on the FLUKE voltmeter.

g. Remove the voltage from the Model 80F-15 high voltage probe.

h. Install the Model 80F-15 front cover and strain relief.

ACCESSORY INFORMATION

MODEL 80-RF HIGH FREQUENCY PROBE

6-1. INTRODUCTION

62. The Model 80-RF High Frequency Probe allows measurements over a frequency range of 100 kHz to 500 MHz from 0.25 to 30 volts when using FLUKE voltmeters having an input impedance of 10 megohms ±10%. The accuracy of measurement is ±5% from 100 kHz to 100 MHz and +7% to 500 MHz. The probe operates into any dc voltmeter having an input impedance of 10 megohms ±10%. A shielded dual-banana plug on the probe permits direct connection to the voltmeter input.

6-3. SPECIFICATIONS

6-4. Electrical

VOLTAGE 0.25V to 30V

RESPONSE: Responds to peak value of input. Calibrated to read rms value of a sine wave input.

AC TO DC TRANSFER ACCURACY:
Loaded with 10 megohms ±10%.

	100 KHz – 100 MHz	100 MHz – 500 MHz
+10°C to +30°C	±5%	±7%
−10°C to +40°C	±7%	±15%

<±3 db at 10 kHz and 700 MHz.

INPUT IMPEDANCE: 4 megohms shunted by 2 ±0.5 pf.

MAXIMUM INPUT: 30 volts rms AC, 200 volts DC.

6-5. General

CABLE CONNECTIONS: Shielded dual banana plug Fits all standard 3/4-inch dual banana connectors.

CABLE LENGTH: 4 ft(121.9 cm) minimum.

WEIGHT: 3-½ oz. net.

ACCESSORIES SUPPLIED
Ground Lead
Straight Tip
Hook Tip
High Frequency Adapter

6-6. OPERATING INSTRUCTIONS

6-7. Connect the shielded dual banana plug directly to the voltmeter input terminals, GND to COMMON or LO. Affix the appropriate probe tip to the probe body, then connect the probe to the high frequency circuit under test. When using the Straight or Hook Tip the ground clip must be connected to the test circuit. When using the high frequency adaptor with appropriate 50 ohm connectors, the ground clip is not required.

6-8. The Straight Tip or Hook Tip supplied with the probe can be used for measurements up to 100 MHz. For measurements above 100 MHz the High Frequency Adapter allows connections to 50 ohm terminations. Ensure that the probe is used in conjunction with dc voltmeters having 10 MΩ ±10% input impedance to meet its specifications.

6-9. The maximum input to the probe is 30 volts rms ac, or 200 volts dc. These factors may be used in combination so that an ac signal may be measured riding on a dc voltage of up to 200 volts. However, it must be noted that if ac superimposed on dc is being measured, the dc level must not be changed by more than 200 volts or the resulting transient is apt to damage the diodes inside the probe.

6-10. THEORY OF OPERATION

6-11. Figure 6-1 contains a schematic diagram of the probe. C1 is a dc blocking capacitor, CR1 is used as a detector, and R1, R3, CR2, R2, and Rin form a divider network. C1, charging through CR1 during the negative half cycle of the input produces a positive dc voltage at the CR1-R1 junction which equals the negative peak value of the input signal. The divider network reduces this to the rms value of the input. It can be seen that the probe must be operated into a 10 MΩ load in order to maintain the proper division ratio.

6-12. CR2 provides compensation for the non-linearity of the detector. R3 is a selected part having a value of 50 kΩ to 100 kΩ, as required for proper divider action.

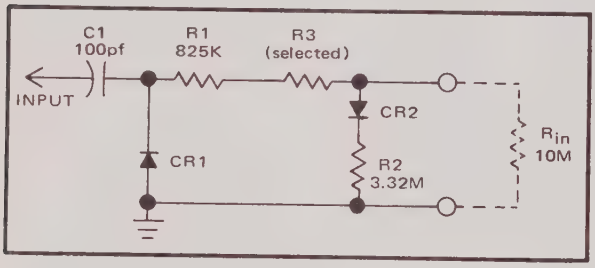


Figure 6-1. SCHEMATIC

6-13. MAINTENANCE

6-14. Performance Checks

6-15. The following checks verify the probe AC to DC Transfer accuracy.

6-16. LOW FREQUENCY RESPONSE. Connect equipment as shown in Figure 6-2, and perform the following steps.

a. With equipment as shown in connection "A" adjust the ac signal source for an output of 3.000 volts rms at 100 kHz as measured on the DVM.

b. In connection "B" with the DVM set to measure dc, observe a probe output of 3.15 to 2.85 volts.

c. Placing cables back in connection "A", decrease the ac signal source by 10db (0.95 volts).

d. Moving back to connection "B", observe a voltmeter indication of between 1.00 and 0.90 volts (10 db down from 3 volts).

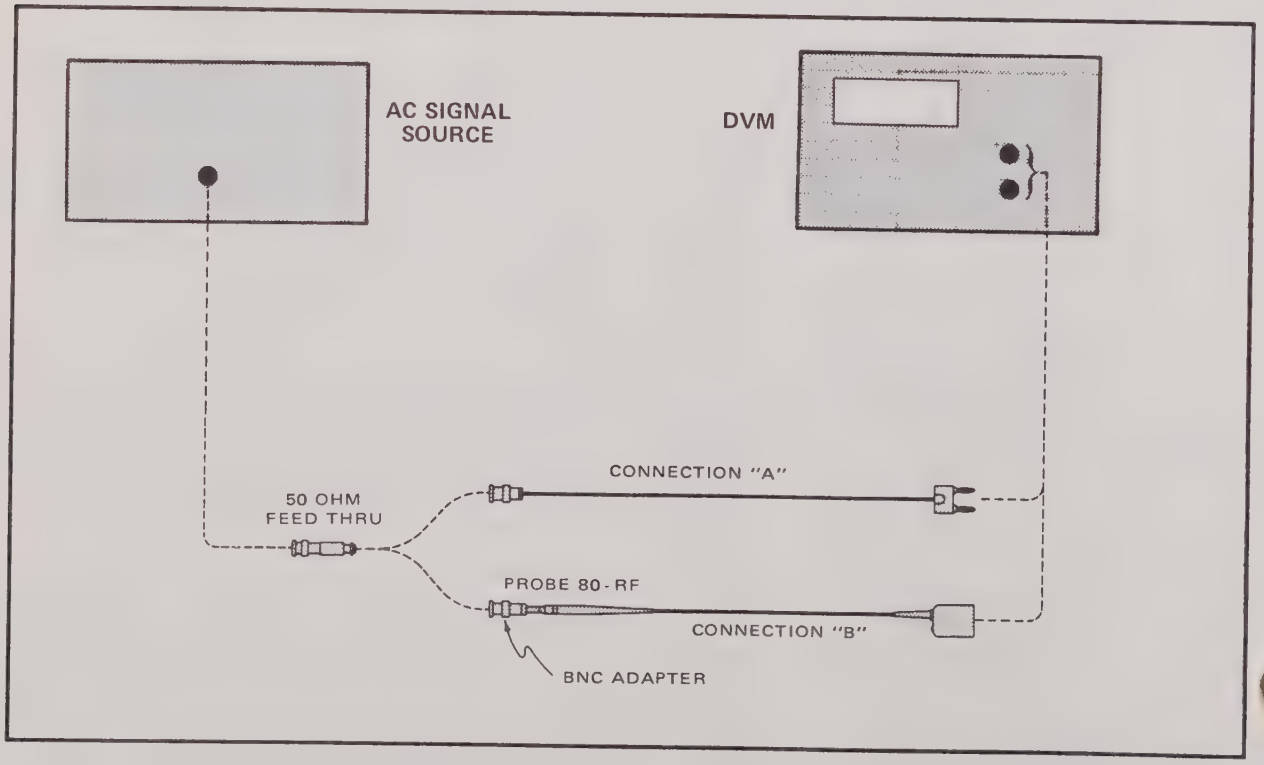


Figure 6-2. LOW FREQUENCY RESPONSE CHECK

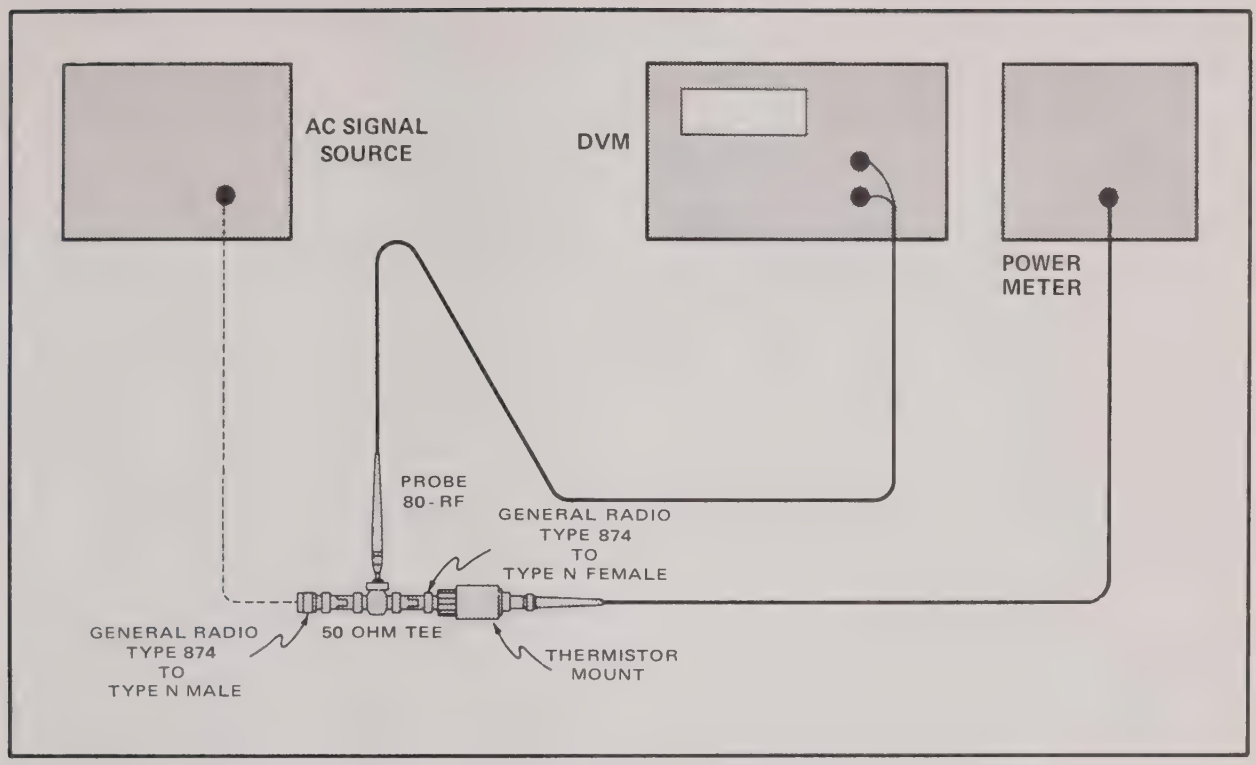


Figure 6-3. HIGH FREQUENCY RESPONSE CHECK

e. In connection "A", decrease the ac signal source an additional 10 db (to 0.3 volts) as indicated by the voltmeter in its ac function.

f. Back to "B", observe a voltmeter reading of .315 to .285 vdc.

g. Return the ac signal source back to 3.000 vrms.

h. Repeat steps a through g with frequencies of 500 kHz, 1 MHz, and 10 MHz.

6-17. HIGH FREQUENCY RESPONSE. Connect equipment to the 80-RF probe as shown in Figure 6-3, and perform the following steps:

a. Set the ac signal source ot 100 MHz with an output level of 10 milliwatts as indicated on the power meter. Ensure that the ac signal source has stabilized at 10 millivolts output.

b. Observe that the voltmeter indication is between 0.757 and 0.657 volts. (0.707 volts corresponds to 10 milliwatts in 50 ohms).

c. Repeat the above for frequencies of 200 MHz, 300 MHz, 400 MHz, and 480 MHz.

6-18. Calibration

6-19. Should the 80-RF require recalibration, perform the following steps:

a. Perform steps a and b in paragraph 6-16, with a frequency of 1 MHz.

b. Observe the dc voltmeter indication; a reading below 3 volts calls for a decrease in the value of R3, a reading above 3 volts calls for an increase in R3. Resistor R3 should be a 1/8 W metal film type. In a probe that is working properly, a 30 kΩ change in R3 will produce about a 1% reading deviation.

6-20. Cleaning

6-21. The Model 80-RF requires a minimum amount of cleaning. Accumulation of dust or dirt particles between the output terminals of the Model 80-RF can be removed using clean dry pressurized air. Stubborn particles can be removed following an application of isopropyl alcohol.

ACCESSORY INFORMATION

MODEL A90 CURRENT SHUNT

6-1. INTRODUCTION

6-2. The Model A90 Current Shunt is designed for use with any high-impedance ac or dc voltmeter capable of accurately measuring 100 millivolts. Six Fluke precision wire wound and strip resistors provide a 100 millivolt full-scale output for each of six pushbutton current ranges: 0.1, 1, 10, 100, and 1000 milliamperes and 10 amperes (ac or dc). Basic accuracy is specified over a frequency range of dc to 4 kHz for the 10 ampere range and dc to 10 kHz for the milliampere ranges.

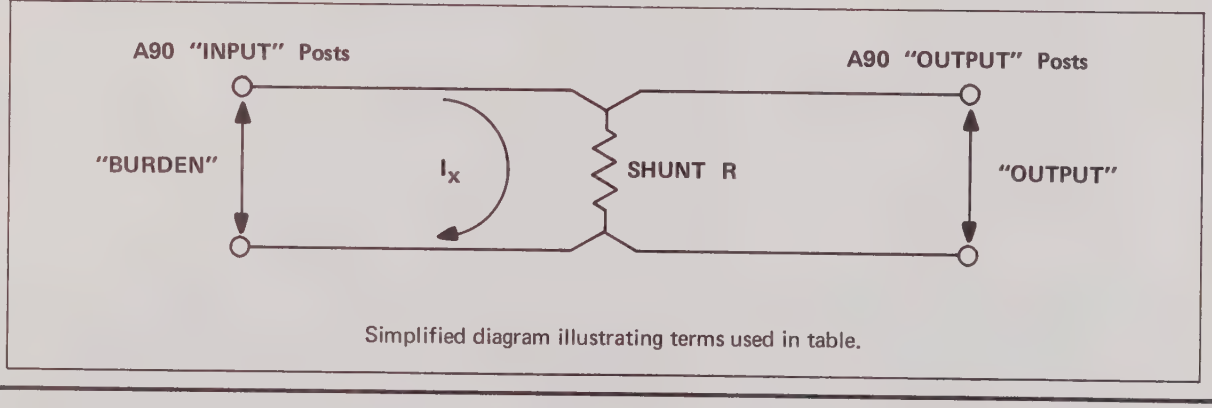
6-3. The instrument is supplied in half-rack case so that it may be conveniently mounted side-by-side with other half-rack instruments in a standard 19-inch rack. A carrying handle detents into custom non-marring feet and serves as a tilt-up bail for bench use.

Figure 6-1. MODEL A90 CURRENT SHUNT

Table 6-1. ACCURACY OF A90 (1 year, 15°C - 35°C)

RATED CURRENT RANGE	E BURDEN (APPROX.)	SHUNT R	"OUTPUT" AT RATED CURRENT	"OUTPUT" ACCURACY AS % OF CURRENT INPUT	
				DC ONLY	DC TO 10 KHZ AC
0.1 ma	100 mv	1 kΩ	100 mv	±0.1%	±0.1%
* 0.1 ma	100 mv	1 kΩ	100 mv	+0.0% −0.2%	+0.0% −0.2%
1.0 ma	100 mv	100Ω	100 mv	±0.1%	±0.1%
10 ma	100 mv	10Ω	100 mv	±0.1%	±0.1%
100 ma	102 mv	1Ω	100 mv	±0.1%	±0.1%
1A	120 mv	0.1Ω	100 mv	±0.1%	±0.2%
10A	300 mv	0.01Ω	100 mv	±0.2%	±0.3% (to 4 kHz)

* With 1 MΩ Input R Voltmeter.
When Input R is ⩾10 MΩ, use non-asterisked 0.1 ma specification.



Simplified diagram illustrating terms used in table.

6-4. SPECIFICATIONS

6-5. Electrical

RANGE
0.1, 1, 10, 100, and 1000 milliamps and 10 amperes.

ACCURACY
Table 6-1 gives accuracy specifications for the Model A90 only. Total current measurement accuracy is also dependent on the accuracy and input impedance of the voltmeter being used.

SENSITIVITY
100 millivolts full scale.

OVERLOAD
Model A90 will not be damaged by 100% overload on each range below 10 amperes or by 50% overload on the 10 ampere range.

6-6. Mechanical

CURRENT SELECTION
Pushbutton, each range.

CONNECTORS
Positive (+) and negative (−) INPUT and OUTPUT binding posts with separate input posts for 10 ampere range.

DIMENSIONS
The Model A90 outline drawing is shown in Figure 6-2.

RACK MOUNTING KITS (OPTIONAL)
MEE-7014: Side-by-side Half-rack Mounting Kit
MEE-7006: Center Rack Mounting Kit
MEE-7013: Left or right of center Mounting Kit.

6-7. AUXILIARY ELECTRICAL SPECIFICATIONS

6-8. Tables 6-2 through 6-6 provide accuracy specifications for the Model A90 when used with Fluke Models

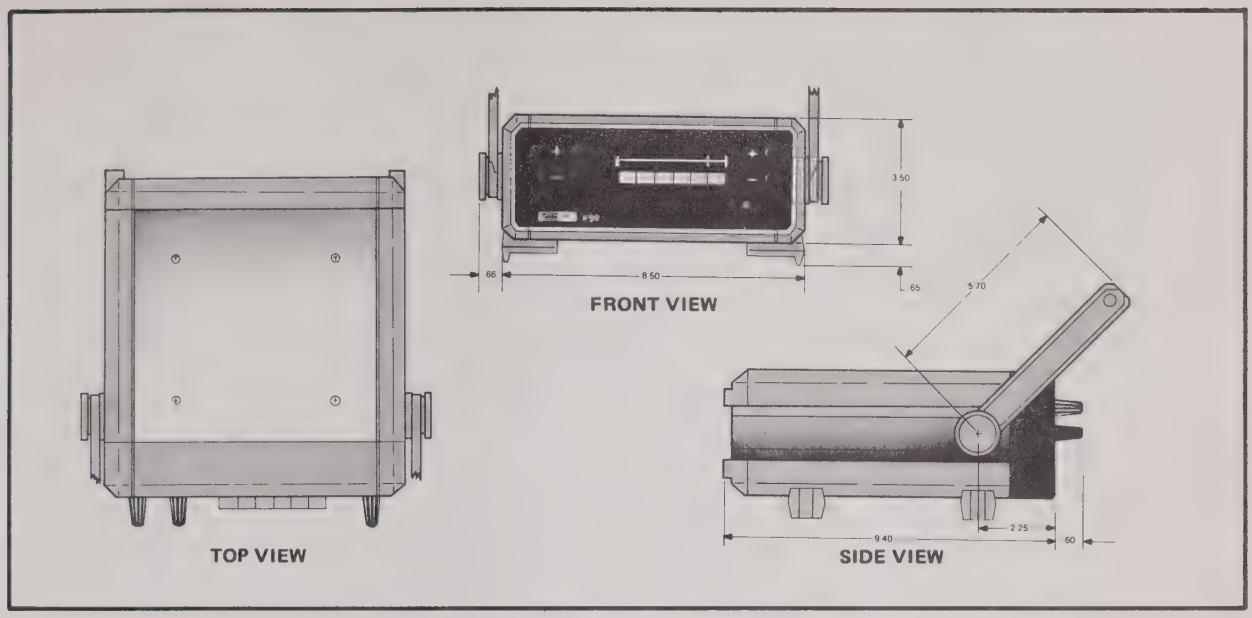


Figure 6-2. MODEL A90 OUTLINE DRAWING

Table 6-2. A90/8100A ACCURACY. 30 days, @ 23°C ±5°C.

DC ACCURACY	
CURRENT RANGE	SPECIFICATION
0.1 ma	±(0.12% of current input + 0.1 ua)
1.0 ma	±(0.12% of current input + 1.0 ua)
10 ma	±(0.12% of current input + 10 ua)
100 ma	±(0.12% of current input + 0.1 ma)
1A	±(0.12% of current input + 1.0 ma)
10A	±(0.22% of current input + 10 ma)

AC ACCURACY		
CURRENT RANGE	30 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.5% of current input + 1.0 ua) –(0.7% of current input + 1.0 ua)	+(0.2% of current input + 0.5 ua) –(0.4% of current input + 0.5 ua)
1.0 ma	±(0.6% of current input + 10 ua)	±(0.3% of current input + 5.0 ua)
10 ma	±(0.6% of current input + 0.1 ma)	±(0.3% of current input + 50 ua)
100 ma	±(0.6% of current input + 1.0 ma)	±(0.3% of current input + 0.5 ma)
1A	±(0.7% of current input + 10 ma)	±(0.4% of current input + 5.0 ma)
10A	±(0.8% of current input + 100 ma)	±(0.5% of current input + 50 ma)*
*10A specified to 4 kHz only.		

For:	DC CURRENT	AC CURRENT
	V_r = 1v	V_r = 1v
	V_{dfs} = ±.1000	V_{dfs} = .1000

Table 6-3. A90/8300A ACCURACY

DC CURRENT ACCURACY

MEASUREMENTS WITHOUT MV/OHMS OPTION INSTALLED

CURRENT RANGE	24 hr @ 23°C ±1°C	90 days @ 23°C ±5°C
0.1 ma	±(0.1% of current input + 0.1 ua)	±(0.11% of current input + 0.3 ua)
1.0 ma	±(0.1% of current input + 1.0 ua)	±(0.11% of current input + 3.0 ua)
10 ma	±(0.1% of current input + 10 ua)	±(0.11% of current input + 30 ua)
100 ma	±(0.1% of current input + 0.1 ma)	±(0.11% of current input + 0.3 ma)
1A	±(0.1% of current input + 1.0 ma)	±(0.11% of current input + 3.0 ma)
10A	±(0.2% of current input + 10 ma)	±(0.21% of current input + 30 ma)

V_r = 10 VDC

V_{dfs} = 0.1000 (Readout also will display "DC +" or "DC –").

MEASUREMENTS WITH MV/OHMS OPTION (8300A-02) INSTALLED

CURRENT RANGE	90 days @ 23°C ±5°C
0.1 ma	±(0.11% of current input + 0.01 ua)
1.0 ma	±(0.11% of current input + 0.1 ua)
10 ma	±(0.11% of current input + 1.0 ua)
100 ma	±(0.11% of current input + 10 ua)
1A	±(0.11% of current input + 0.1 ma)
10A	±(0.21% of current input + 1.0 ma)

V_r = 100 MV (0.1v)

V_{dfs} = 100.000 (Readout will also display MV DC + or MV DC–)

AC CURRENT ACCURACY

MEASUREMENTS WITH AC OPTION 8300A-01 INSTALLED

90 days @ 23°C ±5°C using AC Zero control periodically.

CURRENT RANGE	30 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.5% of current input + 0.05 ua) –(0.7% of current input + 0.05 ua)	+(0.1% of current input + 0.05 ua) –(0.3% of current input + 0.05 ua)
1.0 ma	±(0.6% of current input + 0.5 ua)	±(0.2% of current input + 0.5 ua)
10 ma	±(0.6% of current input + 5.0 ua)	±(0.2% of current input + 5.0 ua)
100 ma	±(0.6% of current input + 50 ua)	±(0.2% of current input + 50 ua)
1A	±(0.7% of current input + 0.5 ma)	±(0.3% of current input + 0.5 ma)
10A	±(0.8% of current input + 5.0 ma)	±(0.4% of current input + 5.0 ma)*

V_r = 1 VAC

V_{dfs} = .10000 (Readout will also display "AC")

*10A specified to 4 kHz only.

Table 6-4. A90/9500A SPECIFICATIONS

ACCURACY WHEN UNKNOWN CURRENT IS 20% OR MORE OF A90 CURRENT RANGE. (23°C ±1°C)

CURRENT RANGE	20 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.3% of current input + 0.02 ua) –(0.5% of current input + 0.02 ua)	+(0.05% of current input + 0.015 ua) –(0.25% of current input + 0.015 ua)
1.0 ma	±(0.4% of current input + 0.2 ua)	±(0.15% of current input + 0.15 ua)
10 ma	±(0.4% of current input + 2.0 ua)	±(0.15% of current input + 1.5 ua)
100 ma	±(0.4% of current input + 20 ua)	±(0.15% of current input + 15 ua)
1A	±(0.5% of current input + 0.2 ma)	±(0.25% of current input + 0.15 ma)
10A	±(0.6% of current input + 2.0 ma)	±(0.35% of current input + 1.5 ma)*

ACCURACY WHEN UNKNOWN CURRENT IS BETWEEN 10% AND 20% OF A90 CURRENT RANGE.

A90 INPUT (% OF CURRENT RANGE)	% OF INPUT ABSOLUTE ACCURACY 20 Hz – 50 Hz @ 23°C ±1°C FOR A90 CURRENT RANGE				
	0.1 ma				
	+	–	1 ma – 100 ma	1A	10A
10-11%	0.53%	0.73%	± 0.63%	±0.73%	±0.83%
12-14%	0.50%	0.70%	± 0.60%	±0.70%	±0.80%
15-17%	0.47%	0.67%	± 0.57%	±0.67%	±0.77%
18-20%	0.44%	0.64%	± 0.54%	±0.64%	±0.74%

A90 INPUT (% OF CURRENT RANGE)	% OF INPUT ABSOLUTE ACCURACY 50 Hz – 10 kHz @23°C ±1°C FOR A90 CURRENT RANGE				
	0.1 ma				
	+	–	1 ma – 100 ma	1A	10A*
10-11%	0.23%	0.43%	±0.33%	±0.43%	±0.53%
12-14%	0.20%	0.40%	±0.30%	±0.40%	±0.50%
15-17%	0.17%	0.37%	±0.27%	±0.37%	±0.47%
18-20%	0.13%	0.33%	±0.23%	±0.33%	±0.43%

V_r = .1v

V_{dfs} = .10000

TC = 0.005% of current input/°C 20 Hz –50 Hz
0.004% of current input/°C 50 Hz – 10 kHz

*10A is specified to 4 kHz only.

8100A, 8300A, 9500A, 891A, 893A, and 931B. Table 6-7 gives V_r and V_{dfs} for each of the voltmeters listed in the tables in addition to various other Fluke voltmeters, where

V_r = Voltage range to be used on the voltmeter
and V_{dfs} = Nominal voltmeter reading with full-scale current in A90 shunt.

6-9. INSTALLATION

6-10. There are three rack-mount kits available, at additional cost, for use with the Model A90. Kit MEE-7014 allows the Model A90 to be mounted side-by-side with another half-rack instrument in a standard 19-inch rack. Kit MEE-7006 supplies hardware necessary to mount the

Table 6-5. A90/891A AND 893A ACCURACY (Sheet 1 of 2)

WITH 891A AND 893A – DC ACCURACY		
CURRENT RANGE	@ 23°C ±2°C	@ 15°C –35°C
0.1 ma	±(0.11% of current input + 0.02 ua)	±(0.12% of current input + 0.02 ua)
1.0 ma	±(0.11% of current input + 0.2 ua)	±(0.12% of current input + 0.2 ua)
10 ma	±(0.11% of current input + 2.0 ua)	±(0.12% of current input + 2.0 ua)
100 ma	±(0.11% of current input + 20 ua)	±(0.12% of current input + 20 ua)
1A	±(0.11% of current input + 0.2 ma)	±(0.12% of current input + 0.2 ma)
10A	±(0.21% of current input + 2.0 ma)	±(0.22% of current input + 2.0 ma)
V_r = 1v V_{dfs} = 0.10000		

WITH 893A – AC ACCURACY @ 23°C ±2°C	
CURRENT RANGE	50 Hz – 10 kHz
0.1 ma	+(0.05% of current input + 0.025 ua) –(0.25% of current input + 0.025 ua)
1.0 ma	±(0.15% of current input + 0.25 ua)
10 ma	±(0.15% of current input + 2.5 ua)
100 ma	±(0.15% of current input + 25 ua)
1A	±(0.25% of current input + 0.25 ma)
10A	±(0.35% of current input + 2.5 ma)*

WITH 893A – AC ACCURACY @ 15°C –35°C		
CURRENT RANGE	5 Hz – 10 Hz	10 Hz – 20 Hz
0.1 ma	+(1.0% of current input + 0.25 ua) –(1.2% of current input + 0.25 ua)	+(0.5% of current input + 0.1 ua) –(0.7% of current input + 0.1 ua)
1.0 ma	±(1.1% of current input + 2.5 ua)	±(0.6% of current input + 1.0 ua)
10 ma	±(1.1% of current input + 25 ua)	±(0.6% of current input + 10 ua)
100 ma	±(1.1% of current input + 0.25 ua)	+(0.6% of current input + 0.1 ma)
1A	±(1.2% of current input + 2.5 ma)	±(0.7% of current input + 1.0 ma)
10A	±(1.3% of current input + 25 ma)	±(0.8% of current input + 10 ma)

893A – AC ACCURACY @ 15°C –35°C.		
CURRENT RANGE	20 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.15% of current input + 0.025 ua) –(0.35% of current input + 0.025 ua)	+(0.1% of current input + 0.025 ua) –(0.3% of current input + 0.025 ua)
1.0 ma	±(0.25% of current input + 0.25 ua)	±(0.2% of current input + 0.25 ua)
10 ma	±(0.25% of current input + 2.5 ua)	±(0.2% of current input + 2.5 ua)
100 ma	±(0.25% of current input + 25 ua)	±(0.2% of current input + 25 ua)
1A	±(0.35% of current input + 0.25 ma)	±(0.3% of current input + 0.25 ma)
10A	±(0.45% of current input + 2.5 ma)	±(0.4% of current input + 2.5 ma)*

Table 6-5. A90/891A AND 893A ACCURACY (Sheet 2 of 2)

	V_r =	1v (AC or DC)
	V_{dfs} =	0.10000

*10A is specified to 4 kHz only.

Table 6-6. A90/931B SPECIFICATIONS

ACCURACY WHEN UNKNOWN CURRENT IS 10% OR MORE OF A90 CURRENT RANGE				
CURRENT RANGE	% OF INPUT ABSOLUTE ACCURACY 2 Hz – 3 Hz	3 Hz – 5 Hz	5 Hz – 30 Hz	SPECIFICATIONS 30 Hz – 10 kHz
0.1 ma	+1.0% –1.2%	+0.5% –0.7%	+0.2% –0.4%	+(0.05% of current input + 5 na) –(0.25% of current input + 5 na)
1.0 ma	±1.1%	±0.6%	±0.3%	±(0.15% of current input + 50 na)
10 ma	±1.1%	±0.6%	±0.3%	±(0.15% of current input + 0.5 ua)
100 ma	±1.1%	±0.6%	±0.3%	±(0.15% of current input + 5 ua)
1A	±1.2%	±0.7%	±0.4%	±(0.25% of current input + 50 ua)
10A	±1.3%	±0.8%	±0.5%	±(0.35% of current input + 0.5 ma)*
TC=	±0.1%/°C	±0.05%/°C	±0.025%/°C	±0.0025%/°C

V_r = 100 MV
V_{dfs} = 100.000

*10A is specified to 4 kHz only.

Table 6-7. "V_r" AND "V_{dfs}" FOR VOLTMETERS OF TABLES 6-2 THROUGH 6-6

VOLTMETER	"V_r"	"V_{dfs}"
8300A (Without MV/Ohms)	10v	.010
8100A, 871A, 873A, 881A, 883A, 885A, 887A, 891A, 893A	1v	.100
801, 803, 801B, 803B, 803D, 821A, 823A, 825A	0.5v	.100
9500A, 910A	0.1v	.100
8300A (With MV/Ohms), 931A, 931B	100 MV	100.0

V_r = Voltage range to be used on the voltmeter.
V_{dfs} = Nominal voltmeter reading with full-scale current in A90 shunt.

instrument in the center of the rack. Kit MEE-7013 supplies two different sized rack ears so that the instrument can be mounted to the left or to the right of rack center.

6-11. OPERATING INSTRUCTIONS

6-12. A description of Model A90 controls and terminals is given in Figure 6-3.

6-13. Equipment Connections

6-14. It is recommended that the Model A90 always be used in the "LO" lead as shown in Figure 6-4A. When used in the "HI" lead, as shown in Figure 6-4B, the distributed capacitance, C_{DIST}, loads the source. When connected in the "HI" lead, the voltmeter guard should either be connected as shown or else the voltmeter should be battery operated.

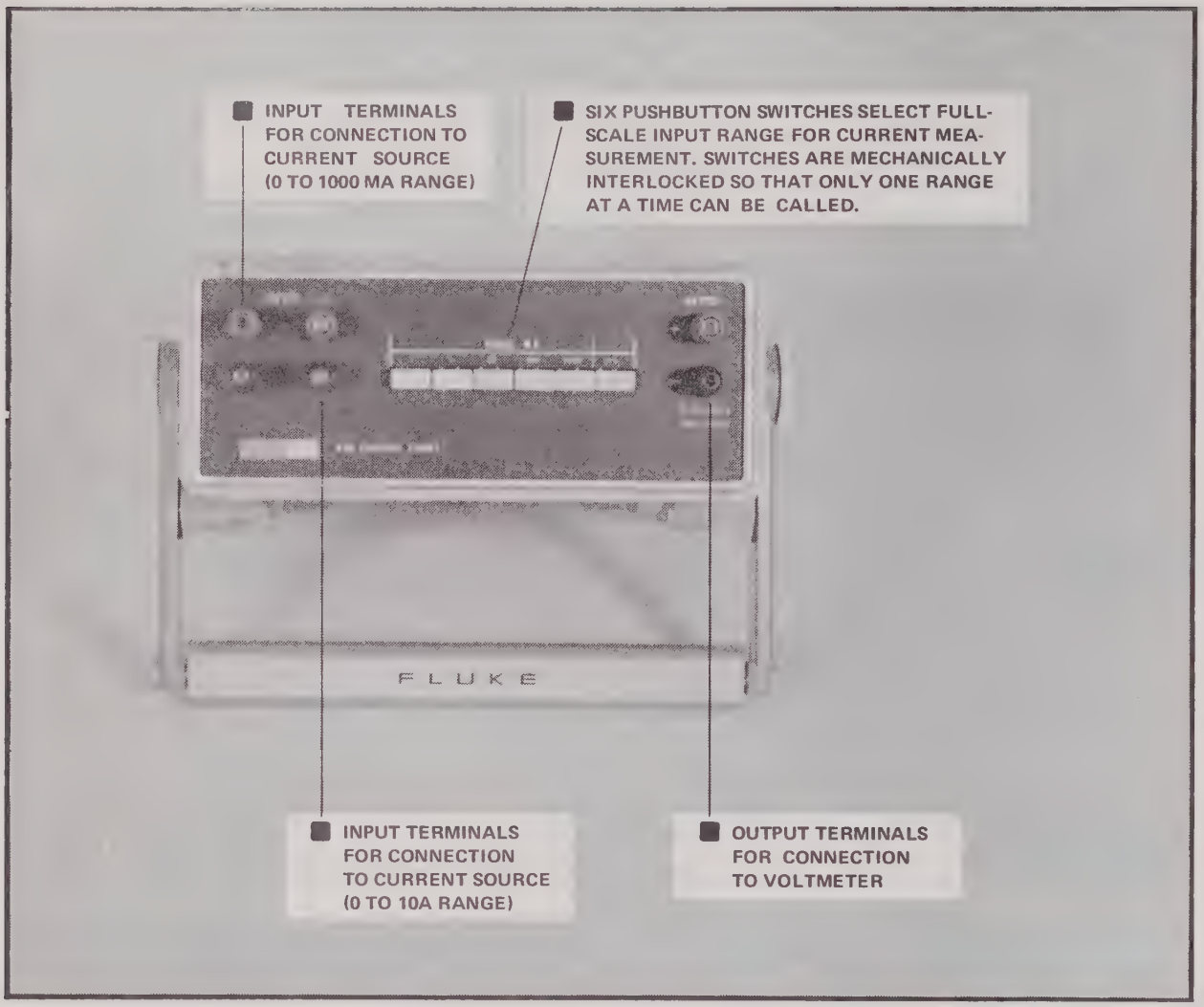

INPUT TERMINALS FOR CONNECTION TO CURRENT SOURCE (0 TO 1000 MA RANGE)
SIX PUSHBUTTON SWITCHES SELECT FULL-SCALE INPUT RANGE FOR CURRENT MEASUREMENT. SWITCHES ARE MECHANICALLY INTERLOCKED SO THAT ONLY ONE RANGE AT A TIME CAN BE CALLED.
FLUKE
INPUT TERMINALS FOR CONNECTION TO CURRENT SOURCE (0 TO 10A RANGE)
OUTPUT TERMINALS FOR CONNECTION TO VOLTMETER

Figure 6-3. MODEL A90 CONTROLS AND TERMINALS.

6-15. At high ac currents, performance of the A90 may depend upon the manner in which the current leads are connected to the input binding posts. Optimum performance is obtained when the input current leads are twisted.

6-16. Voltmeter Impedance

6-17. The input impedance of the voltmeter which is used with the Model A90 is significant with regard to total measurement accuracy. As indicated in the specifications, Model A90 measurement accuracy is derated for voltmeters having finite input impedance. As the voltmeter input capacity increases, the Model A90 response rolls off at the high end; and as the voltmeter input resistance decreases, the response shifts downward, resulting in negative measurement errors.

6-18. Combining Model A90 And Voltmeter Specifications

6-19. Combined specifications for the A90 when used with various Fluke voltmeters is given in Tables 6-2 through 6-6. When the A90 is used with other voltmeters, the following information may be used to combine specifications.

6-20. Equation 1 (Figure 6-5) is used to combine A90 and voltmeter specifications for overall accuracy. The "W" term is taken from Table 6-1, and the "X", "Y" and "Z" terms are taken from voltmeter specifications (data sheets). All Fluke voltmeter specifications, except the Model 910A, contain the "X" term; they usually list the "Y" term and occasionally the "Z" term. Model 910A accuracy specifi-

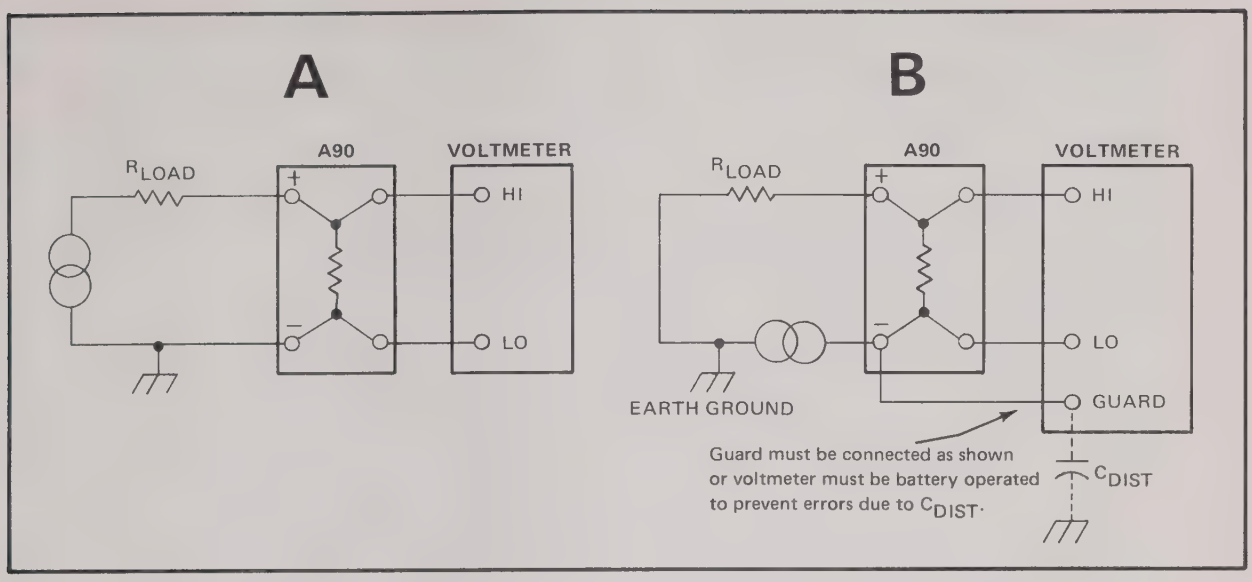


Figure 6-4. EQUIPMENT CONNECTIONS FOR CURRENT MEASUREMENT.

EQUATION 1. COMBINING A-90 SPECIFICATION WITH VOLTMETER SPECIFICATION.

A-90 Specification (from Table 6-1)

Voltmeter Specification (from Voltmeter Data Sheet)

$$\pm\ W\%\qquad \pm\ (\ X\%\ \text{of input} + Y\%\ \text{of range} + Z\ \text{uv}\ )$$

Vr = Lowest voltmeter range that will measure 100 MV

$$= \pm\left[\ (W + X)\%\ \text{of current input} + \frac{Vr}{0.1} \times \left(Y + \frac{Z}{10000}\right)\%\ \text{of current range}\right]$$

EXAMPLE 1: Accuracy using 10 ma DC A-90 range with 891A.

A-90 Specification (from Table 6-1)

891A Specification (from 891A Data Sheet)

$$\pm\ 0.1\%\qquad \pm\ (\ 0.01\%\ \text{of input} + 0.001\%\ \text{of range} + 10\ \text{uv}\ )$$

Vr 1.0 (891A's 1v DC Range)

$$= \pm\left[\ (0.1 + 0.01)\%\ \text{of current input} + \frac{1.0}{0.1} \times \left(0.001 + \frac{10}{10{,}000}\right)\%\ \text{of current range}\right]$$

$$= \pm\left[\ 0.11\%\ \text{of current input} + 0.02\%\ \text{of current range}\ \right]$$

$$= \pm\left[\ 0.11\%\ \text{of current input} + 2\ \text{ua}\ \right]$$

Figure 6-5. EQUATION 1 – COMBINING A90 AND VOLTMETER SPECIFICATIONS (Sheet 1 of 2)

EXAMPLE 2: Accuracy using 0.1 ma AC A-90 range with 873A at 1 kHz.

Model 873A has 1 megohm input impedance in its AC mode so separate accuracy statements are required for positive and negative limits of error for measurements made on the A-90's 0.1 ma range.

Positive Limit of Error

A-90 Specification: + | 0.0 | %

873A Specification: ± | 0.2 | % of input + | 25 | uv

"Vr" is 873A's 1v AC Range

No "Y" Term In Spec.

$$= +\left[(0.0 + 0.2)\ \%\ \text{of current input} + \frac{1}{0.1} \times \left(0 + \frac{25}{10000}\right)\ \%\ \text{of current range}\right]$$

$$= +\left[\ 0.2\%\ \text{of current input} + 0.025\%\ \text{of current range}\ \right]$$

Negative Limit of Error

$$= -\left[\ (0.2 + 0.2)\ \%\ \text{of current input} + 0.025\%\ \text{of current range}\ \right]$$

$$= -\left[\ 0.4\%\ \text{of current input} + 0.025\%\ \text{of current range.}\ \right]$$

Figure 6-5. EQUATION 1 – COMBINING A90 AND VOLTMETER SPECIFICATIONS (Sheet 2 of 2)

cation consists of "Y" term only. If "X", "Y", or "Z" do not appear in a voltmeter accuracy specification, it should be treated as a zero in Equation 1. The voltmeter must be used on the lowest range that can measure 100 millivolts. This range is assigned the symbol "V_r" in Equation 1. V_r is always stated as volts, i.e., 100 millivolt range equals 0.1 volts for V_r .

6-21. Equation 2 (Figure 6-6) may be used to convert the voltmeter voltage reading to current.

6-22. THEORY OF OPERATION

6-23. The schematic diagram of the Model A90 is located at the back of the manual. In the milliampere ranges, current is directed through the appropriate shunt resistor by switches S1A through S5A, and the corresponding output voltage is connected to the output terminals through switches S1 through S5, decks B and C. In 10 ampere range, the input current is applied directly to the shunt resistor, and the output voltage is connected to the output terminals through switch S6.

6-24. All shunt resistors are four-terminal shunts or are connected in a four-terminal switching arrangement so that lead resistance does not affect measurement accuracy.

6-25. MAINTENANCE

6-26. The following paragraphs contain instructions for cleaning and calibrating the Model A90.

6-27. Cleaning

6-28. The instrument should be cleaned periodically to remove dust, grease, and other contamination. The following procedure should be adhered to when cleaning the instrument:

a. Remove loose contamination with low-pressure, clean, dry air.

b. Clean front panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened in a mild solution of detergent and water.

CAUTION!

Do not use aromatic hydrocarbons or chlorinated solvents on the front panel, because they will react with the Lexan binding posts.

$$I_x = I_r \times \frac{V_d}{V_{dfs}}$$

Where: I_x = magnitude of unknown current in units of A90 "RANGE" used. (i.e. ma or amps).

I_r = A90 Rated Current "RANGE".

V_d = Voltmeter reading.

V_{dfs} = Nominal Voltmeter reading with rated current flowing in A90. "V_{dfs}" and "V_r" are tabulated in Table 6-7 for each voltmeter listed in Tables 6-2 through 6-6. Note that "V_{dfs}" multiplies or divides "V_d" by powers of 10 so it is simple to manipulate.

EQUATION 2. CONVERTING VOLTAGE READINGS TO CURRENT

Example: An 8100A reads =.0643 when used with an A90 in the 10 ma range. What current is flowing?

I_r = 10 ma (A90 "Rated Current Range")

V_d = .0643 (Voltmeter reading)

V_{dfs} = .1000 (From Table 6-7)

Answer: $I_x = 10 \text{ ma} \times \frac{.0643}{.1000} = 6.43 \text{ ma}$

Figure 6-6. Equation 2 – CONVERTING VOLTAGE READINGS TO CURRENT

6-29. Test Equipment

6-30. Test equipment required for calibration and testing of the Model A90 is shown in Table 6-8. If the recommended equipment is not available, other equivalent equipment may be used.

Table 6-8. LIST OF TEST EQUIPMENT

NAME	RECOMMENDED EQUIPMENT
Constant Current Source	Fluke Model 382A
DC Differential Voltmeter	Fluke Model 895A or 885A
Low-Thermal Leads	
4-Terminal Ohmmeter	Fluke Model 8300A with Option -02

6-31. Calibration

6-32. PRELIMINARY CHECKS. Make the resistance checks shown in Table 6-9. Values are approximate since check is intended to show only gross errors, such as defective or open resistors.

6-33. .1 MA AND 1 MA RANGE CHECKS. Connect the ohmmeter and A90, as shown in Figure 6-7, for 4-terminal resistance measurements, and perform the following steps:

a. Set the A90 to the .1 MA range. The ohmmeter should indicate between 1.00050 and 0.99950 kilohms. If the measured resistance is not within these limits, the .1 MA shunt, R6, is defective and must be replaced.

b. Set the A90 to the 1 MA range. The ohmmeter should indicate between 100.07 and 99.93 ohms. If the measured resistance is not within these limits, the 1 MA shunt, R5, is defective and must be replaced.

6-34. 10 MA, 100 MA, AND 1000 MA RANGE CHECKS. Connect the constant current generator, differential voltmeter, and A90 as shown in Figure 6-8 and perform the following steps:

a. Set the A90 to the 10 MA range.

b. Set the differential voltmeter controls as follows:

RANGE	1 Volt
NULL Sensitivity	100 μV
Readout Dials	0.100000

Table 6-9. RESISTANCE CHECKS

OHMMETER CONNECTIONS	MODEL A90	
	RANGE	APPROXIMATE RESISTANCE (OHMS)
INPUT Terminals	.1 MA	1000
	1 MA	100
	10 MA	10
	100 MA	1
	1000 MA	0.1
	10A	∞
INPUT (10A Terminals)	10A	0.01
OUTPUT Terminals	10A	0.01
	1000 MA	0.1
	100 MA	1
	10 MA	10
	1 MA	100
	.1 MA	1000

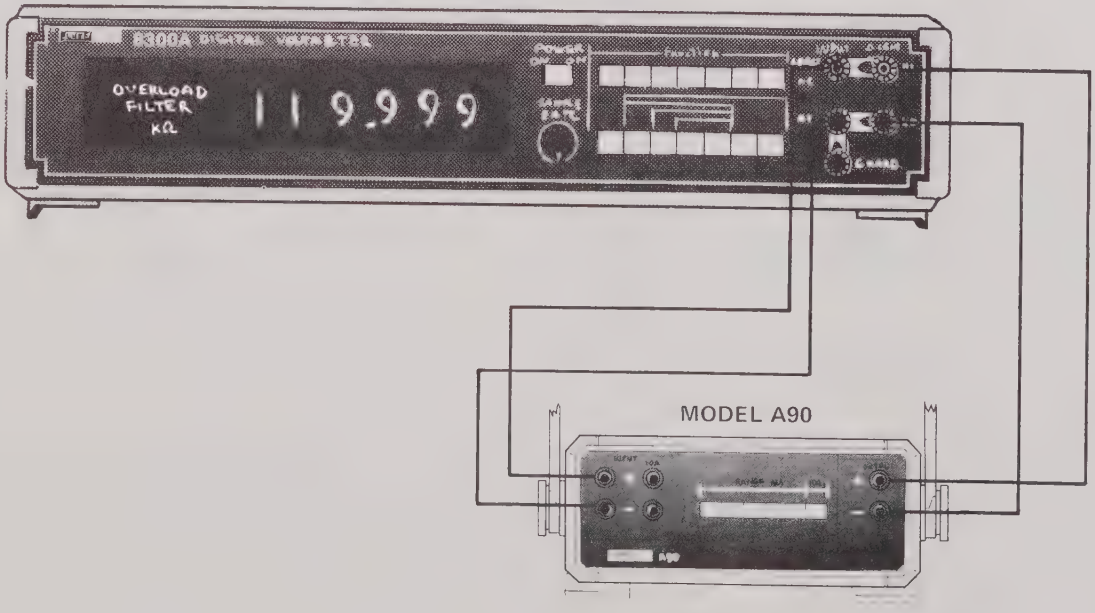


Figure 6-7. EQUIPMENT CONNECTIONS – .1 MA AND 1 MA RANGE CHECKS

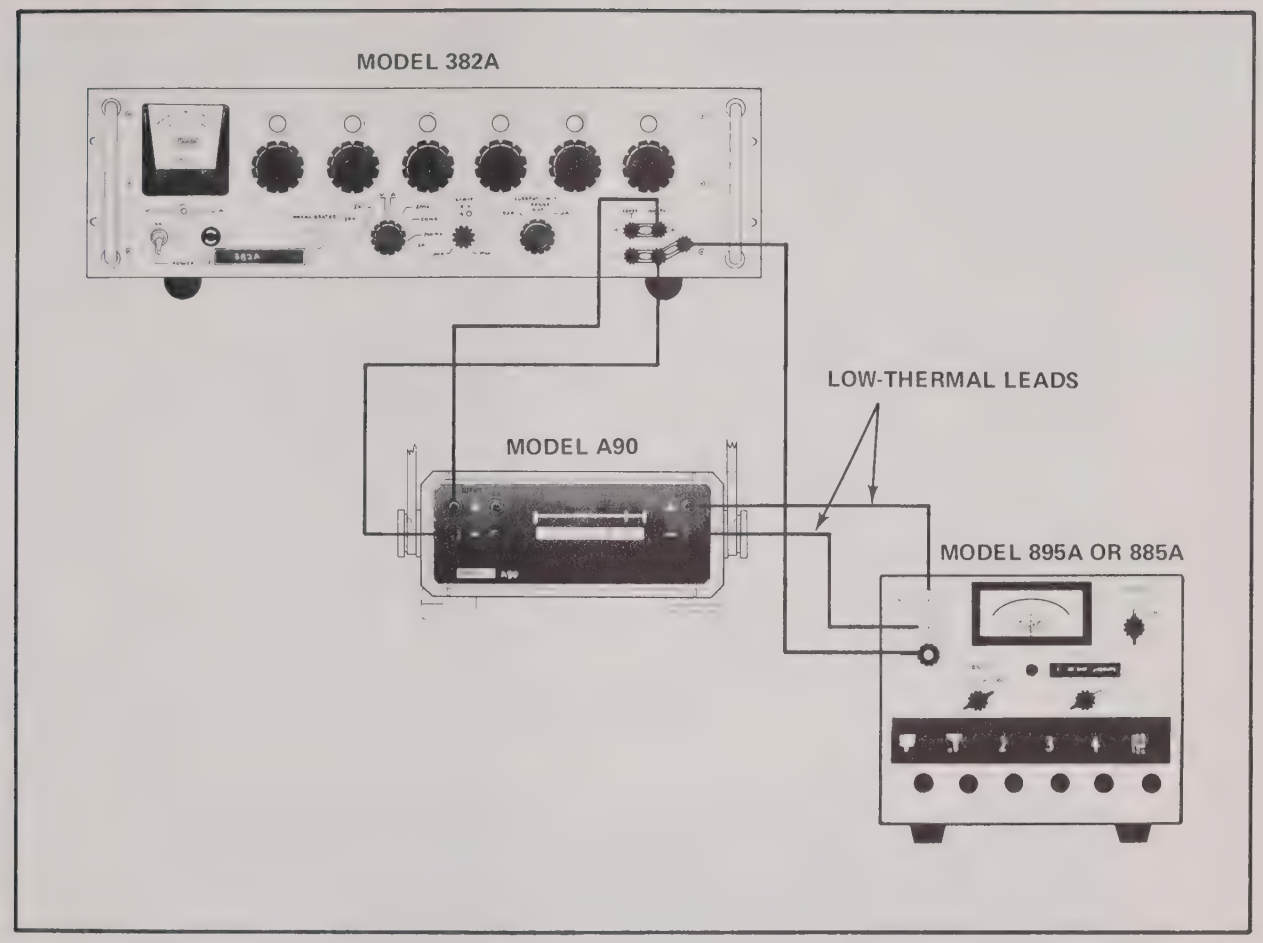


Figure 6-8. EQUIPMENT CONNECTIONS – 10 MA, 100 MA, AND 1000 MA RANGE CHECKS

c. Set the constant current generator for 10.0000 milliamperes output. The differential voltmeter should indicate null within ±80 micorvolts. If the voltmeter does not indicate within these limits, the 10 MA shunt, R4, is defective and must be replaced.

d. Change the A90 range to 100 MA and the constant current generator output to 100 milliamperes. The differential voltmeter should indicate null within ±80 microvolts. If the voltmeter does not indicate within these limits, the 100 MA shunt, R3, is defective and must be replaced.

e. Change the A90 range to 1000 MA and the constant current generator output to 1000 milliamperes. The differential voltmeter should indicate null within ±80 microvolts. If the +80 microvolt limit is not met, the 1000 MA shunt, R2, should be replaced. If the –80 microvolt limit is not met, R2 is low in ohmic value and can be trimmed to its desired value by carefully removing a small amount of material from the edge of the shunt using a whetstone.

6-35. 10 AMPERE RANGE CHECK. Connect equipment as shown in Figure 6-8, leaving the constant current generator temporarily disconnected from the A90, and perform the following steps:

a. Set the differnetial voltmeter controls as follows:

RANGE	1 Volt
NULL Sensitivity	100 μV
Readout Dials	0.00000

The voltmeter should indicate less than ±4 microvolts of thermal offset. If more than ±4 microvolts of offset is observed, check for cold solder joints or possible thermal generators in the test

setup. When thermal offset has been reduced to within ±4 microvolts, proceed to step (b).

b. Connect the constant current generator to the 10 AMP binding posts of the A90 and set the A90 to the 10A range.

c. Set the differential voltmeter controls as follows:

RANGE	1 Volt
NULL Sensitivity	100 μV
Readout Dials	.020000

d. Set the constant current generator output to 2 amperes. The voltmeter should indicate null within ±80 microvolts. If the +80 microvolt limit is not met, the 10 ampere shunt, R1, should be replaced. If the −80 microvolt limit is not met, R1 is low in ohmic value and can be trimmed to its desired value by carefully removing a small amount of material from the edge of the shunt using a whetstone.

6-36. LIST OF REPLACEABLE PARTS

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
		CURRENT SHUNT – Figure 6-9	A90					
		Shunt PCB Assembly (See Figure 6-9)	A90-403	89536	A90-403	1		
J1, J2, J5		Binding post, red, +	275552	89536	275552	3		
J3, J4, J6		Binding post, black –	275560	89536	275560	3		
		Cover, bottom	224360	89536	224360	1		
		Cover, top	224352	89536	224352	1		
		Foot	230037	89536	230337	4		
		Handle, carrying	231423	89536	231423	1		
		Panel, front	A90-208	89536	A90-208	1		
		Panel, rear	A90-209	89536	A90-209	1		

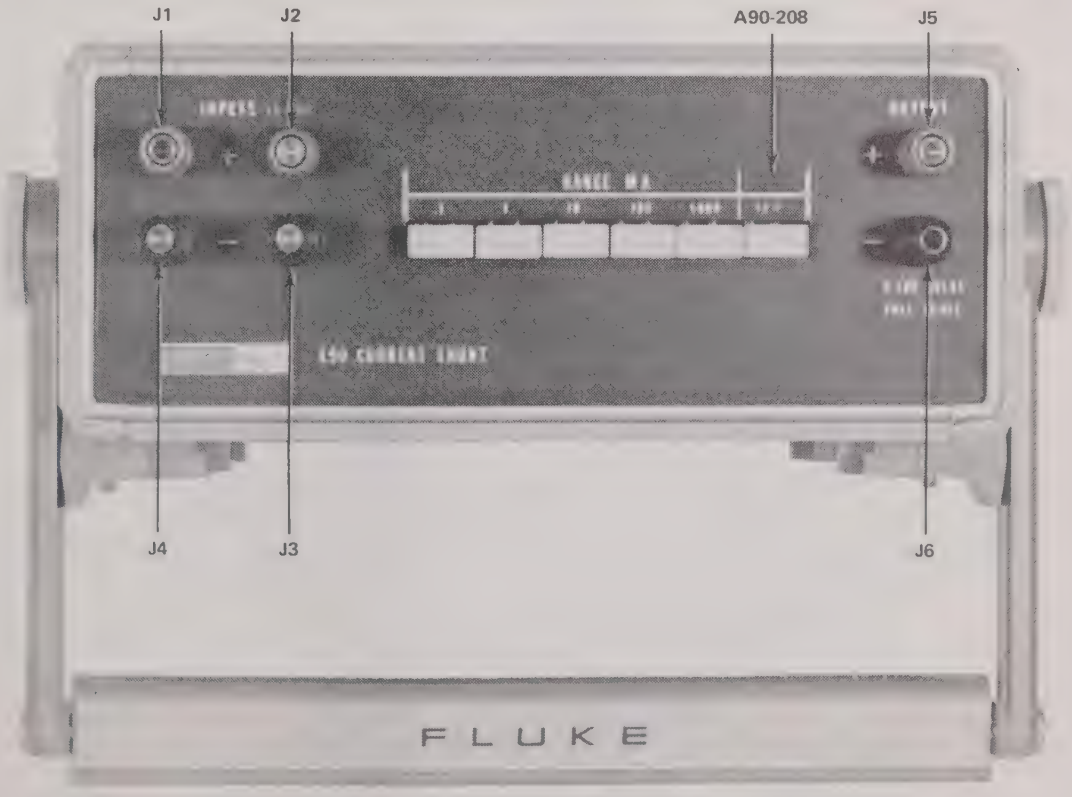


Figure 6-9. MODEL A90 CURRENT SHUNT (Sheet 1 of 2)

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
		SHUNT PCB ASSEMBLY – Figure 6-9	A90-403	89536	A90-403	REF		
R1		Res, ww, 0.010Ω ±0.2%, 1w	34-4022	89536	34-4022	1		
R2		Res, ww, 0.10Ω ±0.1%, 1w	224121	89536	224121	1		
R3		Res, ww, 1.0Ω ±0.1%, ½w	224089	89536	224089	1		
R4		Res, ww, 10Ω ±0.1%, ½w	224071	89536	224071	1		
R5		Res, ww, 100Ω ±0.03%, ½w	155846	89536	155846	1		
R6		Res, ww, 1 KΩ ±0.04%, ½w	131706	89536	131706	1		
S1 thru S6		Switch assembly, RANGE MA	A90-802	89536	A90-802	1		

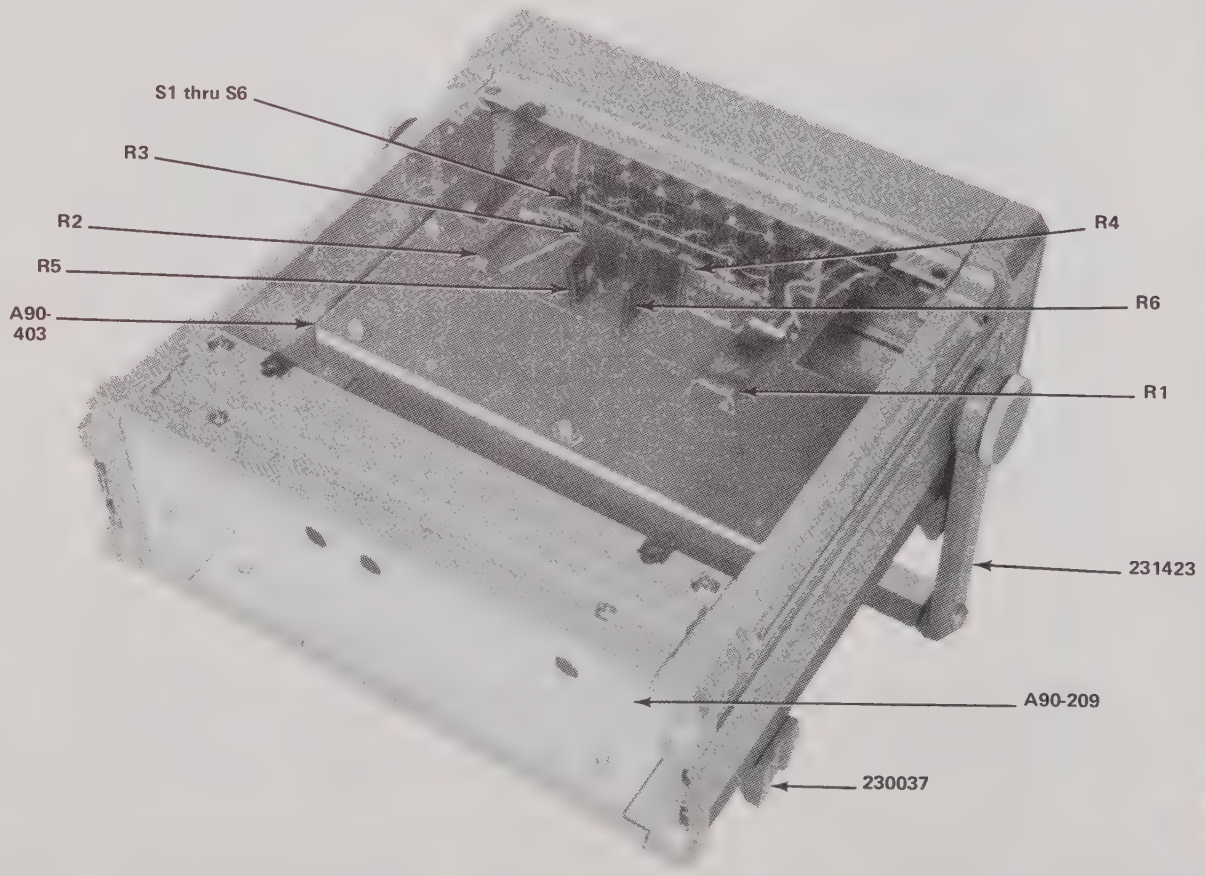
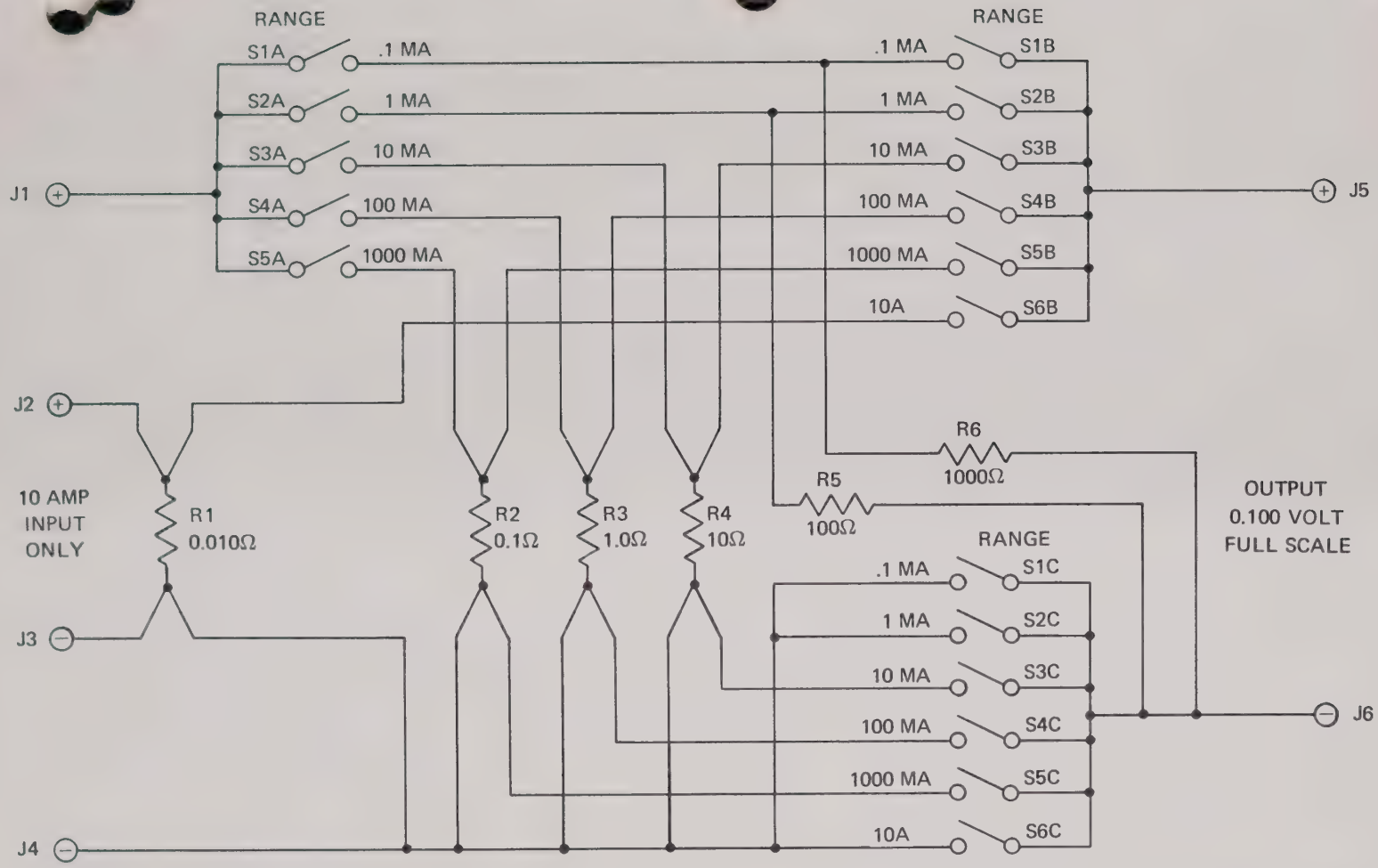


Figure 6-9. MODEL A90 CURRENT SHUNT (Sheet 2 of 2)



FUNCTIONAL SCHEMATIC DIAGRAM

MODEL A90

CURRENT SHUNT

SER. NO. 123 & ON

REV a

FLUKE JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133

Section 7
General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

List of Abbreviations and Symbols

A or amp	ampere
ac	alternating current
af	audio frequency
a/d	analog-to-digital
assy	assembly
AWG	american wire gauge
B	bel
bcd	binary coded decimal
°C	Celsius
cap	capacitor
ccw	counterclockwise
cer	ceramic
cermet	ceramic to metal(seal)
ckt	circuit
cm	centimeter
cmrr	common mode rejection ratio
comp	composition
cont	continue
crt	cathode-ray tube
cw	clockwise
d/a	digital-to-analog
dac	digital-to-analog converter
dB	decibel
dc	direct current
dmm	digital multimeter
dvm	digital voltmeter
elect	electrolytic
ext	external
F	farad
°F	Fahrenheit
FET	Field-effect transistor
ff	flip-flop
freq	frequency
FSN	federal stock number
g	gram
G	giga (10^9)
gd	guard
Ge	germanium
GHz	gigahertz
gmv	guaranteed minimum value
gnd	ground
H	henry
hd	heavy duty
hf	high frequency
Hz	hertz
IC	integrated circuit
if	intermediate frequency
in	inch(es)
intl	internal
I/O	input/output
k	kilo (10^3)
kHz	kilohertz
kΩ	kilohm(s)
kV	kilovolt(s)
lf	low frequency
LED	light-emitting diode
LSB	least significant bit
LSD	least significant digit
M	mega (10^6)
m	milli (10^{-3})
mA	milliampere(s)
max	maximum
mf	metal film
MHz	megahertz
min	minimum
mm	millimeter
ms	millisecond
MSB	most significant bit
MSD	most significant digit
MTBF	mean time between failures
MTTR	mean time to repair
mV	millivolt(s)
mv	multivibrator
MΩ	megohm(s)
n	nano (10^{-9})
na	not applicable
NC	normally closed
(-) or neg	negative
NO	normally open
ns	nanosecond
opnl ampl	operational amplifier
p	pico (10^{-12})
para	paragraph
pcb	printed circuit board
pF	picofarad
pn	part number
(+) or pos	positive
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
PROM	programmablle read-only memory
psi	pound-force per square inch
RAM	random-access memory
rf	radio frequency
rms	root mean square
ROM	read-only memory
s or sec	second (time)
scope	oscilloscope
SH	shield
Si	silicon
serno	serial number
sr	shift register
Ta	tantalum
tb	terminal board
tc	temperature coefficient or temperature compensating
tcxo	temperature compensated crystal oscillator
tp	test point
u or μ	micro (10^{-6})
uhf	ultra high frequency
us or μs	microsecond(s) (10^{-6})
uut	unit under test
V	volt
v	voltage
var	variable
vco	voltage controlled oscillator
vhf	very high frequency
vlf	very low frequency
W	watt(s)
ww	wire wound
xfmr	transformer
xstr	transistor
xtal	crystal
xtlo	crystal oscillator
Ω	ohm(s)
μ	micro (10^{-6})

Federal Supply Codes for Manufacturers

00213
Nytronics Comp. Group Inc.
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisburg, Pennsylvania

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics Inc.
Manchester, New Hampshire

01730
Replaced by 73586

01884
Use 56289
Sprague Electric Co.
Dearborn Electronic Div.
Lockwood, Florida

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Harris ASW Div.
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Snelgrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 1M2

02606
Fenwal Labs
Div. of Travenal Labs.
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div.
Formerly Amphenol-Borg
Electric Corp.
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products
Syracuse, New York

03614
Replaced by 71400

03651
Replaced by 44655

03797
Eldema Div.
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp.
Whippany, New Jersey

03911
Clairex Electronics Div.
Clairex Corp.
Mt. Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222
AVX Ceramics Div.
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc.
Chicago, Illinois

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp.
Materials Systems Div.
New York, New York

05571
Use 56289
Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Electronic Capacitor &
Battery Products Dept.
Columbia, South Carolina

06136
Replaced by 63743

06383
Panduit Corp
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol SAMS Div.
Chatsworth, California

06555
Beede Electrical Instrument Co
Penacook, New Hampshire

06739
Electron Corp
Littleton, Colorado

06743
Clevite Corp
Cleveland, Ohio

06751
Components, Inc. Semcor Div.
Phoenix, Arizona

06860
Gould Automotive Div.
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div.
Bedford, Ohio

06980
Eimac Div.
Varian Associates
San Carlos, California

07047
The Ross Milton Co.
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Div.
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp.
Div. of BBF Group Inc
Chelmsford, Massachusetts

07261
Aumet Corp.
Culver City, California

07263
Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344
Bircher Co., Inc
Rochester, New York

07597
Burndy Corp
Tape/Cable Div
Rochester, New York

07792
Lerma Engineering Corp.
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933
Use 49956
Raytheon Co
Semiconductor Div HQ
Mountain View, California

08225
Industro Transistor Corp
Long Island City, New York

Federal Supply Codes for Manufacturers (cont)

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

08806
General Electric Co.
Miniature Lamp Products Dept
Cleveland, Ohio

08863
Nylomatic Corp.
Norrisville, Pennsylvania

08988
Use 53085
Skottie Electronics Inc.
Archbald, Pennsylvania

09214
G.E. Co. Semi-Conductor
Products Dept.
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components, Inc.
Santa Barbara, California

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

10059
Barker Engineering Corp.
Formerly Amerace, Amerace
ESNA Corp.
Kenilworth, New Jersey

11236
CTS of Berne
Berne, Indiana

11237
CTS Keene Inc.
Paso Robles, California

11358
CBS Electronic Div.
Columbia Broadcasting System
Newburyport, Minnesota

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

11711
General Instrument Corp.
Rectifier Division
Hicksville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12040
National Semiconductor Corp.
Danburry, Connecticut

12060
Diodes, Inc.
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12300
Potter-Brumfield Div.
AMF Canada LTD.
Guelph, Ontario, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp. formerly
Freeway Washer & Stamping Co.
Cleveland, Ohio

12443
The Budd Co. Polychem Products
Plastic Products Div.
Bridgeport, Pennsylvania

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12749
James Electronics
Chicago, Illinois

12856
Micrometals
Sierra Madre, California

12954
Dickson Electronics Corp.
Scottsdale, Arizona

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Amphenol Cadre Div.
Bunker-Ramo Corp.
Los Gatos, California

13606
Use 56289
Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp.
Newbury Park, California

14140
Edison Electronic Div.
Mc Gray-Edison Co.
Manchester, New Hampshire

14193
Cal-R-Inc. formerly
California Resistor, Corp.
Santa Monica, California

14298
American Components, Inc.
an Insilco Co.
Conshohocken, Pennsylvania

14655
Cornell-Dublier Electronics
Division of Federal Pacific
Electric Co. Govt. Control Dept.
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp.
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Trol Inc.
Saugus, California

15801
Fenwal Electronics Inc.
Div. of Kidde Walter and Co., Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors,
formerly Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc.
Burbank, California

16299
Corning Glass
Electronic Components Div.
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Div. of Chemed Corporation
Cambridge, Maryland

16742
Paramount Plastics
Fabricators, Inc.
Downey, California

16758
Delco Electronics
Div. of General Motors Corp.
Kokomo, Indiana

17001
Replaced by 71468

17069
Circuit Structures Lab.
Burbank, California

17338
High Pressure Eng. Co., Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc.
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc.
Maryland Heights, Missouri

18324
Signetics Corp.
Sunnyvale, California

18612
Vishay Resistor Products Div.
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18736
Voltronics Corp.
Hanover, New Jersey

18927
GTE Sylvania Inc.
Precision Material Group
Parts Division
Titusville, Pennsylvania

19451
Perine Machinery & Supply Co.
Seattle, Washington

19701
Electro-Midland Corp.
Mepco-Electra Inc.
Mineral Wells, Texas

20584
Enochs Mfg. Inc.
Indianapolis, Indiana

Federal Supply Codes for Manufacturers (cont)

20891
Self-Organizing Systems, Inc.
Dallas, Texas

21604
Bucheye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Transistor Division
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Inc.
Rockville, Maryland

23880
Stanford Applied Engrng.
Santa Clara, California

23936
Pamotor Div., Wm. J. Purdy Co.
Burlingame, California

24248
Replaced by 94222

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

24759
Lenox Fugle Electronics Inc.
South Plainfield, New Jersey

25088
Siemen Corp.
Isilen, New Jersey

25403
Amperex Electronic Corp.
Semiconductor &
Micro-Circuits Div.
Slatersville, Rhode Island

27014
National Semiconductor Corp.
Santa Clara, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
Consumer Products Div.
St. Paul, Minnesota

28425
Serv-/-Link formerly
Bohannan Industries
Fort Worth, Texas

28478
Deltrol Controls Div.
Deltrol Corporation
Milwaukee, Wisconsin

28480
Hewlett Packard Co.
Corporate HQ
Palo Alto, California

28520
Heyman Mfg. Co.
Kenilworth, New Jersey

29083
Monsanto, Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30148
AB Enterprise Inc.
Ahoskie, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

31091
Optimax Inc.
Colmar, Pennsylvania

32539
Mura Corp.
Great Neck, New York

32767
Griffith Plastic Corp.
Burlingame, California

32879
Advanced Mechanical
Components
Northridge, California

32897
Erie Technological Products, Inc.
Frequency Control Div.
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Products Division
Riverside, California

33173
General Electric Co.
Products Dept.
Owensboro, Kentucky

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

37942
P.R. Mallory & Co., Inc.
Indianapolis, Indiana

42498
National Radio
Melrose, Massachusetts

43543
Nytronics Inc.
Transformer Co. Div.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

54294
Cutler-Hammer Inc. formerly
Shallcross, A Cutter-Hammer Co.
Selma, North Carolina

55026
Simpson Electric Co.
Div. of Am. Gage and Mach. Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

60399
Torin Corp. formerly
Torrington Mfg. Co.
Torrington, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

64834
West Mfg. Co.
San Francisco, California

65092
Weston Instruments Inc.
Newark, New Jersey

66150
Winslow Tele-Tronics Inc
Eaton Town, New Jersey
70485
Atlantic India Rubber Works
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71002
Birnback Radio Co., Inc.
Freeport, New York

71400
Bussmann Mfg.
Div. of McGraw-Edison Co.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare, C.P. & Co.
Chicago, Illinois

71590
Centrelab Electronics
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707
Coto Coil Co., Inc.
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Cinch Connector Operations Div.
Elk Grove Village
Chicago, Illinois

72005
Wilber B. Driver Co.
Newark, New Jersey

72092
Replaced by 06980

72136
Electro Motive Mfg. Co.
Williamantic, Connecticut

72259
Nytronics Inc.
Pelham Manor, New Jersey

72619
Dialight Div
Amperex Electronic Corp.
Brooklyn, New York

72653
G.C. Electronics
Div. of Hydrometals, Inc
Brooklyn, New York

72665
Replaced by 90303
72794
Dzus Fastener Co., Inc
West Islip, New York

72928
Gulton Ind. Inc
Gudeman Div
Chicago, Illinois

Federal Supply Codes for Manufacturers (cont)

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Bechman Instrument Inc.
Helipot Division
Fullerton, California

73293
Hughes Aircraft Co.
Electron Dynamics Div.
Torrance, California

73445
Amperex Electronic Corp.
Hicksville, New York

73559
Carling Electric Inc.
West Hartford, Connecticut

73586
Circle F Industries
Trenton, New Jersey

73734
Federal Screw Products, Inc.
Chicago, Illinois

73743
Fischer Special Mfg. Co.
Cincinnati, Ohio

73899
JFD Electronics Co.
Components Corp.
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74199
Quan Nichols Co.
Chicago, Illinois

74217
Radio Switch Corp.
Marlboro, New Jersey

74276
Signalite Div.
General Instrument Corp.
Neptune, New Jersey

74306
Piezo Crystal Co.
Carlisle, Pennsylvania

74542
Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970
Johnson E.F., Co.
Waseca, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75376
Kurz-Kasch Inc.
Dayton, Ohio

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

76854
Oak Industries Inc.
Switch Div.
Crystal Lake, Illinois

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, Indiana

77638
General Instrument Corp.
Rectifier Division
Brooklyn, New York

77969
Rubbercraft Corp. of CA. LTD.
Torrance, California

78189
Shakeproof
Div. of Illinois Tool Works Inc.
Elgin, Illinois

78277
Sigma Instruments, Inc.
South Braintree, Massachusetts

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp. Engineered
Fastener Div.
Tinnerman Plant
Cleveland, Ohio

79136
Waldes Kohinoor Inc.
Long Island City, New York

79497
Western Rubber Company
Goshen, Indiana

79963
Zierick Mfg. Corp.
Mt. Kisko, New York

80031
Electro-Midland Corp.
Mepco Div.
A North American Phillips Co.
Norristown, New Jersey

80145
LFE Corp., Process Control Div.
formerly API Instrument Co.
Chesterland, Ohio

80183
Use 56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div.
Riverside, California

80583
Hammarlund Mfg. Co., Inc.
Red Bank, New Jersey

80640
Arnold Stevens, Inc.
South Boston, Massachusetts

81073
Grayhill, Inc.
La Grange, Illinois

81312
Winchester Electronics
Div. of Litton Industries Inc.
Oakville, Connecticut

81483
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp.
Los Angeles, California

81590
Korry Mfg. Co.
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82305
Palmer Electronics Corp.
South Gate, California

82389
Switchcraft Inc.
Chicago, Illinois

82415
North American Phillips
Controls Corp.
Frederick, Maryland

82872
Roanwell Corp.
New York, New York

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
Varo Inc.
Garland, Texas

83058
The Carr Co., United Can Div.
of TRW
Cambridge, Massachusetts

83298
Bendix Corp.
Electric Power Div.
Eatontown, New Jersey

83330
Herman H. Smith, Inc.
Brooklyn, New York

83478
Rubbercraft Corp.
of America, Inc.
West Haven, Connecticut

83594
Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740
Union Carbide Corp.
Battery Products Div.
formerly Consumer Products Div.
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
TRW Capacitors
Ogallala, Nebraska

84613
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Industrial Wire Div.
Peabody, Massachusetts

86577
Precision Metal Products
of Malden Inc.
Stoneham, Massachusetts

86684
Radio Corp. of America
Electronic Components Div.
Harrison, New Jersey

86928
Seastrom Mfg. Co., Inc.
Glendale, California

87034
Illuminated Products Inc.
Subsidiary of Oak Industries Inc.
Anahiem, California

88219
Gould Inc.
Industrial Div.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Federal Pacific Co.
Fuquay-Varian, North Carolina

88486
Plastic Wire & Cable
Jewitt City, Connecticut

88690
Replaced by 04217

89536
John Fluke Mfg. Co., Inc.
Seattle, Washington

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

Federal Supply Codes for Manufacturers (cont)

90201
Mallory Capacitor Co.
Div. of P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211
Use 56365
Square D Co.
Chicago, Illinois

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

90303
Mallory Battery Co.
Div. of Mallory Co., Inc.
Tarrytown, New York

91094
Essex International Inc.
Suglex/IWP Div.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91407
Replaced by 58474

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

91737
Use 71468
Gremar Mfg. Co., Inc
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co., Inc.
Tuckahoe, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co., Inc.
Div. of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145
Replaced by 49956

94154
Use 94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp.
Lester, Pennsylvania

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95264
Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
Rolling Meadows, Illinois

95712
Bendix Corp.
Electrical Components Div.
Microwave Devices Plant
Franklin, Indiana

95987
Weckesser Co. Inc.
Chicago, Illinois

96733
San Fernando Electric Mfg. Co.
San Fernando, California

96853
Gulton Industries Inc.
Measurement and Controls Div.
formerly Rustrak Instruments Co.
Manchester, New Hampshire

96881
Thomson Industries, Inc.
Manhasset, New York

97540
Master Mobile Mounts, Div. of
Whitehall Electronics Corp.
Ft. Meyers, Florida

97913
Industrial Electronic
Hardware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdot Co., Inc.
Connector & Cable Div
Pasadena, California

98291
Sealectro Corp.
Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98743
Replaced by 12749

98925
Replaced by 14433

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect.
Comp. Div.
formerly Southern Elect. Div.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Div. of ITT Jennings formerly
Marshall Industries Capacitor Div.
Monrovia, California

99779
Use 29587
Bunker-Ramo Corp.
Barnes Div.
Landsdowne, Pennsylvania

99800
American Precision Industries Inc.
Delevan Division
East Aurora, New York

99942
Centrelab Semiconductor
Centrelab Electronics Div. of
Globe-Union Inc.
El Monte, California

Toyo Electronics
(R-Ohm Corp.)
Irvine, California

National Connector
Minneapolis, Minnesota

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Burbank, CA 91504
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Section 8
Schematic Diagrams

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A28 True RMS Converter, Schematic	8200A-1028
Wiring Diagram and Input Power Schematic	8200A-1000

MODEL 8200A
TROUBLESHOOTING PROCEDURE

POWER-OFF CHECKS

1. Inspect instrument for improperly seated plug-in assemblies, loose wires, physically damaged parts or other obvious problems.
2. Check fuses including fuse F1 on the Ohms Converter, assembly A2.
3. Check that the 115/230 volt line switch is in the proper position. This switch is located on the transformer bracket at the rear of the instrument and is accessible after removing the top dust cover and inner guard cover.

POWER-ON CHECKS

1. Ensure that the instrument is being operated properly. Refer to Section 2 of the manual for proper operating instructions.
2. Perform all of the performance checks in Section 4 of the manual. This will aid in identifying the problem so that localization of the trouble can be accomplished.

Localization of Problems to a Section

To aid in localizing troubles in the Model 8200A, the basic instrument can be broken down into three major sections: analog, digital and power supply.

The analog section consists of Input Buffer A4. It supplies a ±1 volt signal to the digital section for any full scale (not overrange) input to the DVM, depending on the polarity of the input.

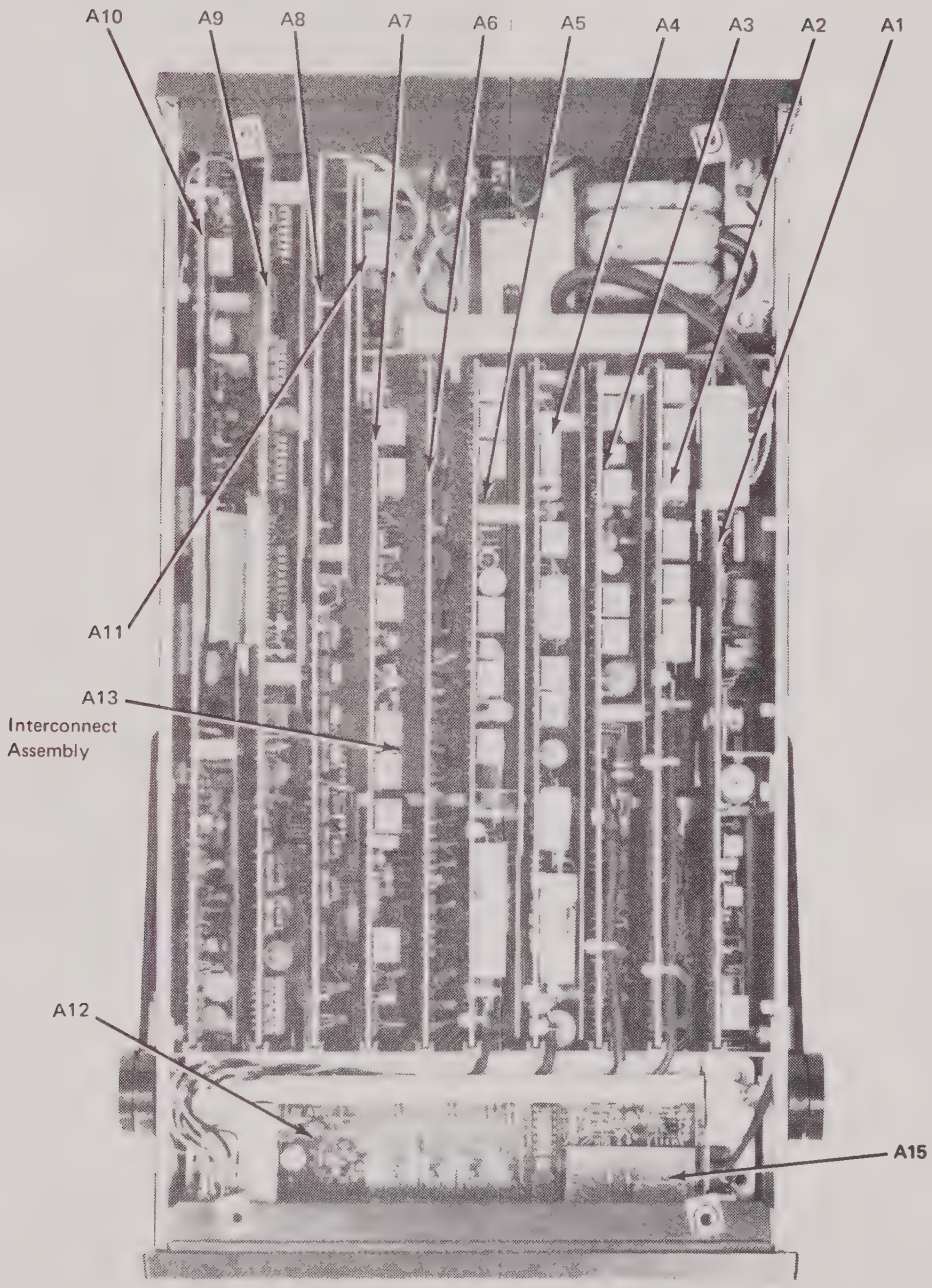
The digital section consists of the following assemblies:

A/D Analog Assembly, A7
Logic Control Assembly, A6
Display Assembly, A12
Interconnect Assembly, A13

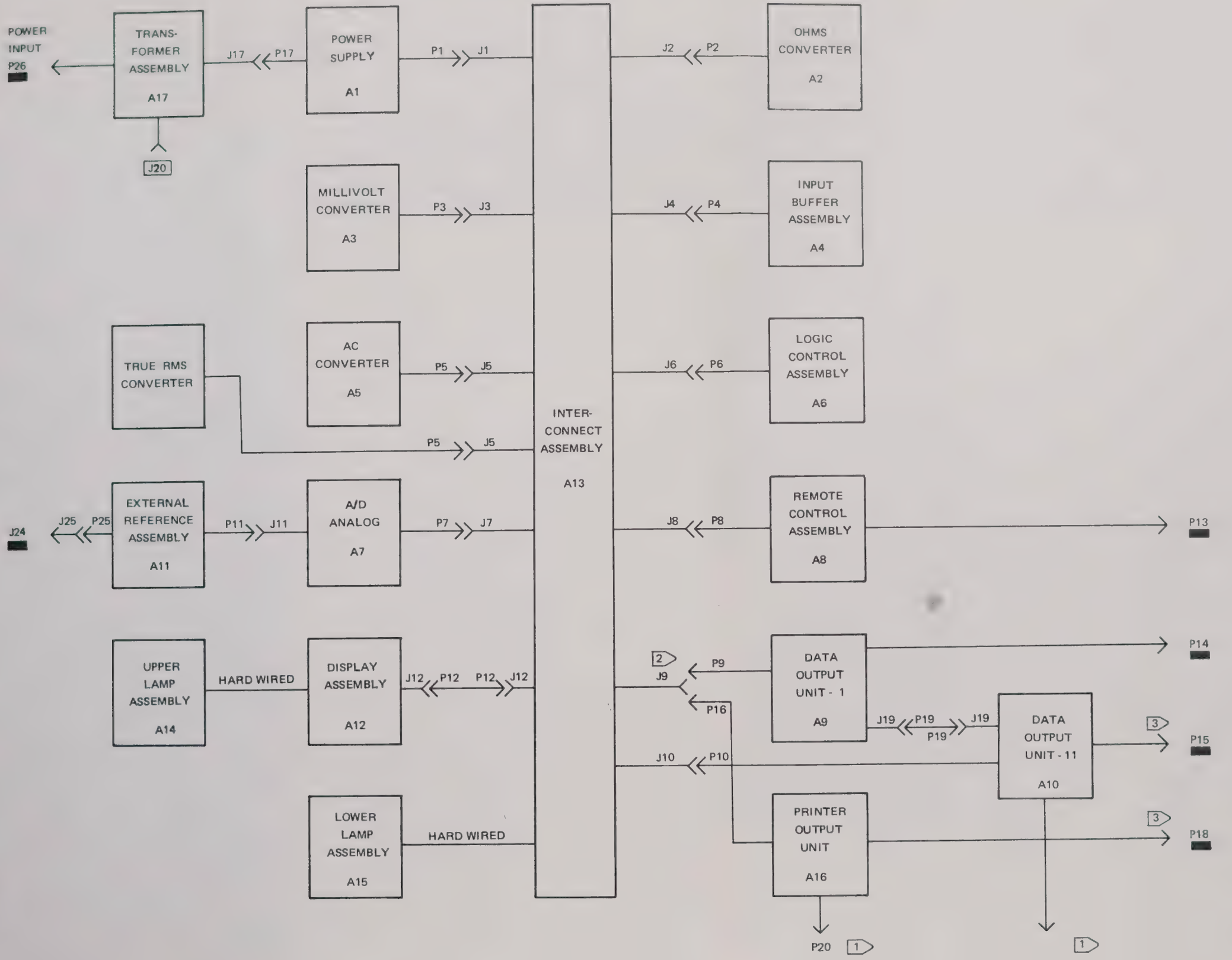
The digital section converts the dc input from the analog section to a digital signal and processes this signal through timing, storage and display circuits for proper readout.

The power supply section consists of Power Supply, A1. This assembly supplies operating voltages to circuitry in both the analog and digital sections.

Isolation of problems to an option assembly can in general be accomplished by making checks of the associated function. For example, if the instrument performs properly for dc voltage inputs but not for ac voltage inputs, it is likely that AC Converter, A5, is faulty.



Initial Troubleshooting Procedure
Drawing No. 8200A-1800



LIST OF SCHEMATICS AND DIAGRAMS

NAME	ASSY. NO.	SCHEM. NO.
ASSEMBLY INTERCONNECT DIAGRAM	NONE	1
POWER SUPPLY	A1	2
OHMS CONVERTER	A2	3
MILLIVOLT CONVERTER	A3	4
INPUT BUFFER ASSEMBLY	A4	5
AC CONVERTER	A5	6
LOGIC CONTRL ASSY.	A6	7
A/D ANALOG	A7	8
REMOTE CONTROL ASSY.	A8	9
DATA OUTPUT UNIT —1	A9	10
DATA OUTPUT UNIT — 11	A10	11
EXTERNAL REFERENCE ASSY	A11	12
DISPLAY ASSEMBLY	A12	13
INTERCONNECT ASSY.	A13	14
PRINTER OUTPUT UNIT	A16	15
TRUE RMS CONVERTER	A28	16
WIRING DIAGRAM AND INPUT POWER SCHEMATIC	NONE	17

NOTES:

1. ▬ DENOTES REAR PANEL CONNECTOR.
2. [1] MATES WITH A17J20 FOR +5V LOGIC SUPPLY INPUT POWER: CONNECTIONS FOR ONE ASSEMBLY ONLY, EIGHER A10 OR A16.
3. [2] EITHER A9P9 A16P16 MATES WITH J9, SINCE DOU AND POU OPTIONS ARE MUTUALLY EXCLUSIVE.
4. [3] P18 AND P15 SHARE THE SAME REAR PANEL LOCATION.

ASSEMBLY INTERCONNECT DIAGRAM

10/75 DRAWING NO. 8200A-1100

MODEL 8200A
TROUBLESHOOTING PROCEDURE

1. Connect Model 8200A and line meter to autotransformer.
2. Connect external voltmeter to A1TP2 (+15V) and A1TP3 (common).
3. Turn Model 8200A on, set line voltage to 115V and observe that external voltmeter reads +15 ±0.01 volts dc.
4. Vary the line voltage from 103V to 127V and note that reading on the external voltmeter changes less than 10mV.
5. Disconnect external voltmeter and connect oscilloscope to A1TP2 and A1TP3.
6. Return line voltage to 115V. Observe that waveshape does not contain any high frequency oscillations and that the peak-to-peak value of waveshape is less than 1 millivolt.

FAULT ANALYSIS

Problems encountered in steps 3 through 6 can be caused by incorrect adjustment of R12 (15 VOLT ADJ), faulty +15V supply or improper internal loads to that supply. To localize problem, remove all plug-in assemblies except A1 from the Model 8200A, connect a 180Ω, 2 watt resistor between A1TP2 and A1TP3 and repeat steps 3 through 6.

7. Connect external voltmeter to A1TP4 (−15V) and A1TP3 (common). External voltmeter should read −15 ±0.4 volts dc.
8. Vary the line voltage from 103V to 127V and note that reading on the external voltmeter changes less than 10mV.
9. Disconnect external voltmeter and connect oscilloscope to A1TP4 and A1TP3.
10. Return line voltage to 115V. Observe that waveshape does not contain any high frequency oscillations and that the peak-to-peak value of waveshape is less than 1mV.

FAULT ANALYSIS

Problems encountered in steps 7 through 10 can be caused by a faulty +15V supply or −15V supply or by improper internal loads to the −15V supply. To localize problem, remove all plug-in assemblies except A1, connect a 180Ω, 2 watt resistor between A1TP4 and A1TP3 and repeat steps 7 through 10.

11. Connect external voltmeter to A1TP5 (+5V) and A1TP3 (common). External voltmeter should read +5.25 ±0.25 volts dc.
12. Vary the line voltage from 103V to 127V and note that reading on the external voltmeter changes less than 10mV.
13. Disconnect external voltmeter and connect oscilloscope to A1TP5 and A1TP3.
14. Return line voltage to 115V. Observe that waveshape does not contain any high frequency oscillations.

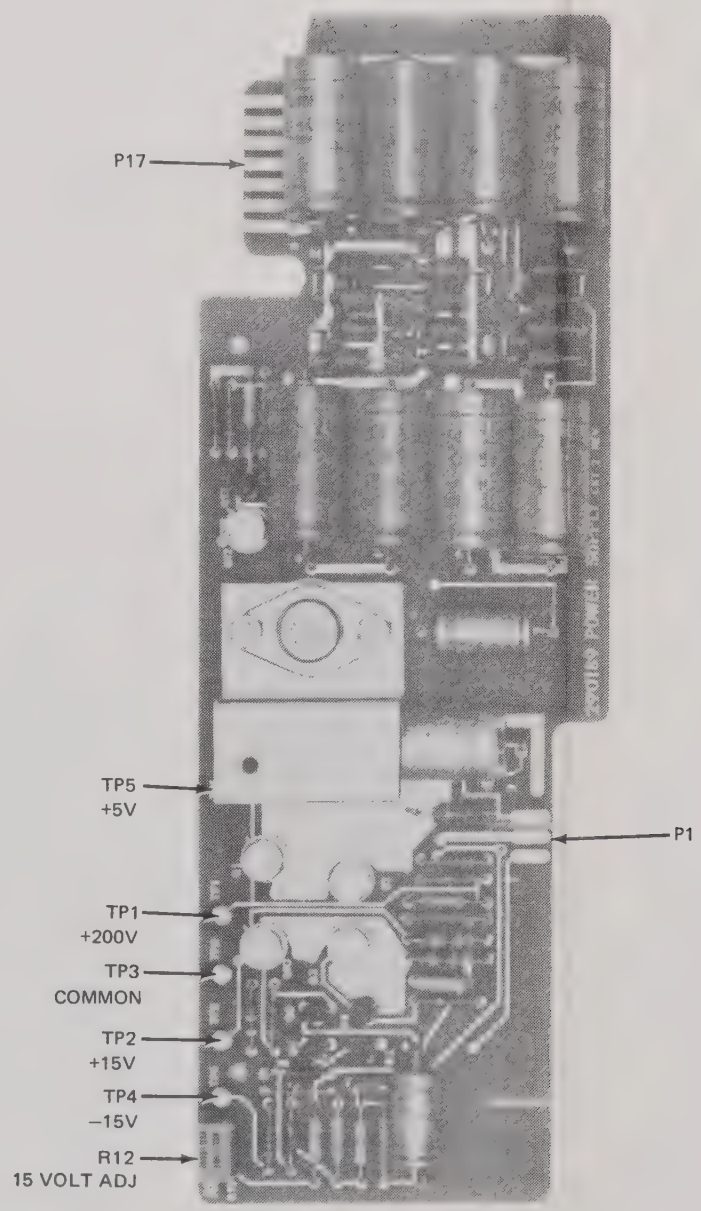
FAULT ANALYSIS

Problems encountered in steps 11 through 14 can be caused by faulty +5V supply or improper internal loading. To localize problem, remove all plug-in assemblies except A1, connect a 4Ω, 10 watt resistor between A1TP5 and A1TP3 and repeat steps 11 through 14.

15. Connect external voltmeter to A1TP1 (+200V) and A1TP3 (common). External voltmeter should read +200 ±8 volts dc.
16. Vary the line voltage from 103V to 127V and note that reading on the external voltmeter changes less than 15V.
17. Disconnect external voltmeter and connect oscilloscope to A1TP1 and A1TP3.
18. Return line voltage to 115V. Observe that waveshape does not contain any high frequency oscillations.

FAULT ANALYSIS

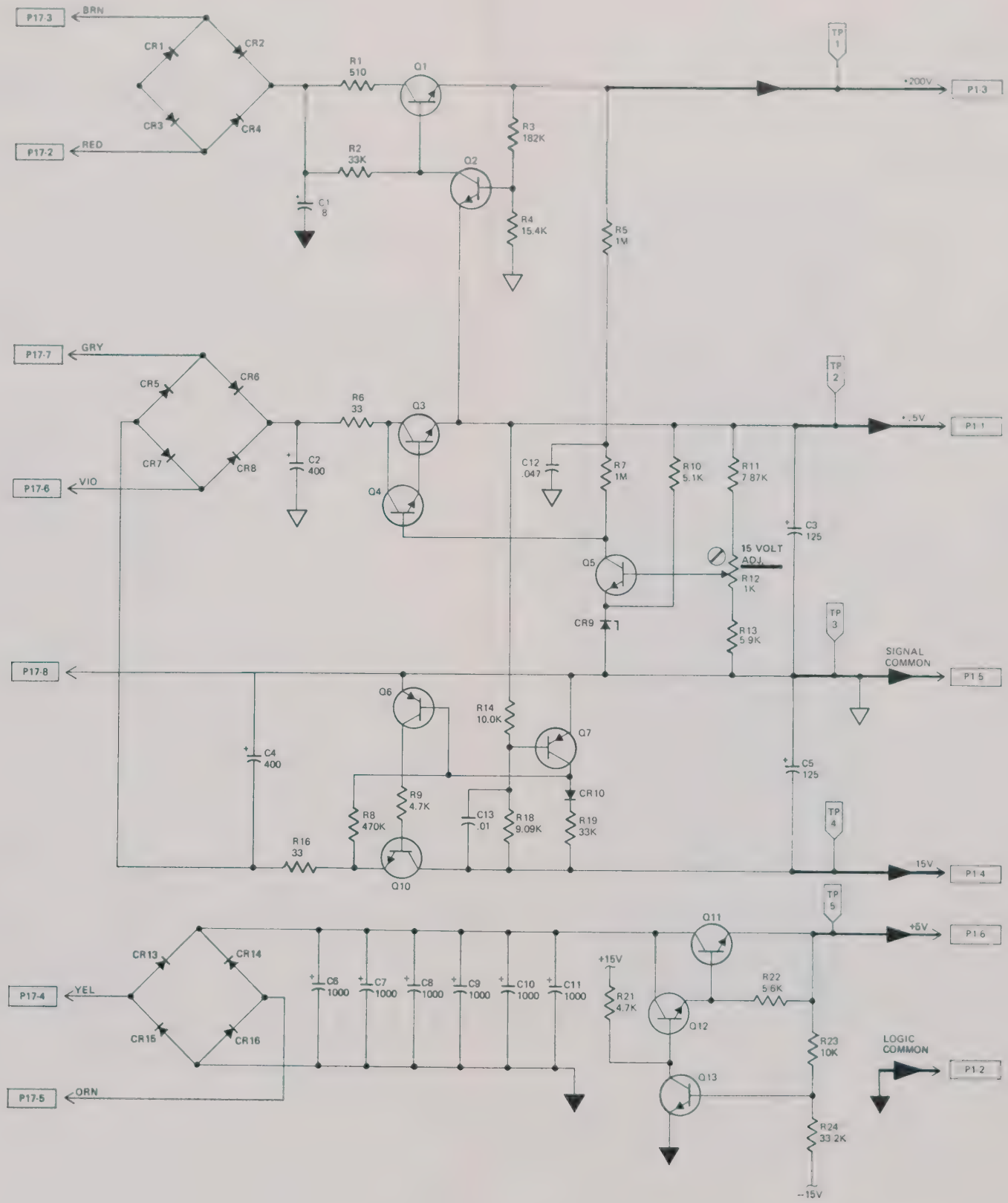
Problems encountered in steps 15 through 18 can be caused by faulty +200V supply or +15V supply or by improper internal loading. To localize problem, remove all assemblies except A1, connect a 10k, 5 watt resistor between A1TP1 and A1TP3 and repeat steps 15 through 18.



TEST EQUIPMENT REQUIRED

Equipment Nomenclature	Recommended Equipment
Autotransformer	Variac Type W5MT3A
Digital Voltmeter	FLUKE Model 8100A
Oscilloscope	Tektronix Model 504
AC Line Meter	RCA Model WV-120A

A1
Power Supply Troubleshooting Procedure
Drawing No. 8200A-1801



NOTES

1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED
2. ⊘ DENOTES INTERNAL ADJUSTMENT
3. ▼ DENOTES LOGIC COMMON
4. ▽ DENOTES SIGNAL COMMON
5. → DENOTES PRIMARY SIGNAL PATH

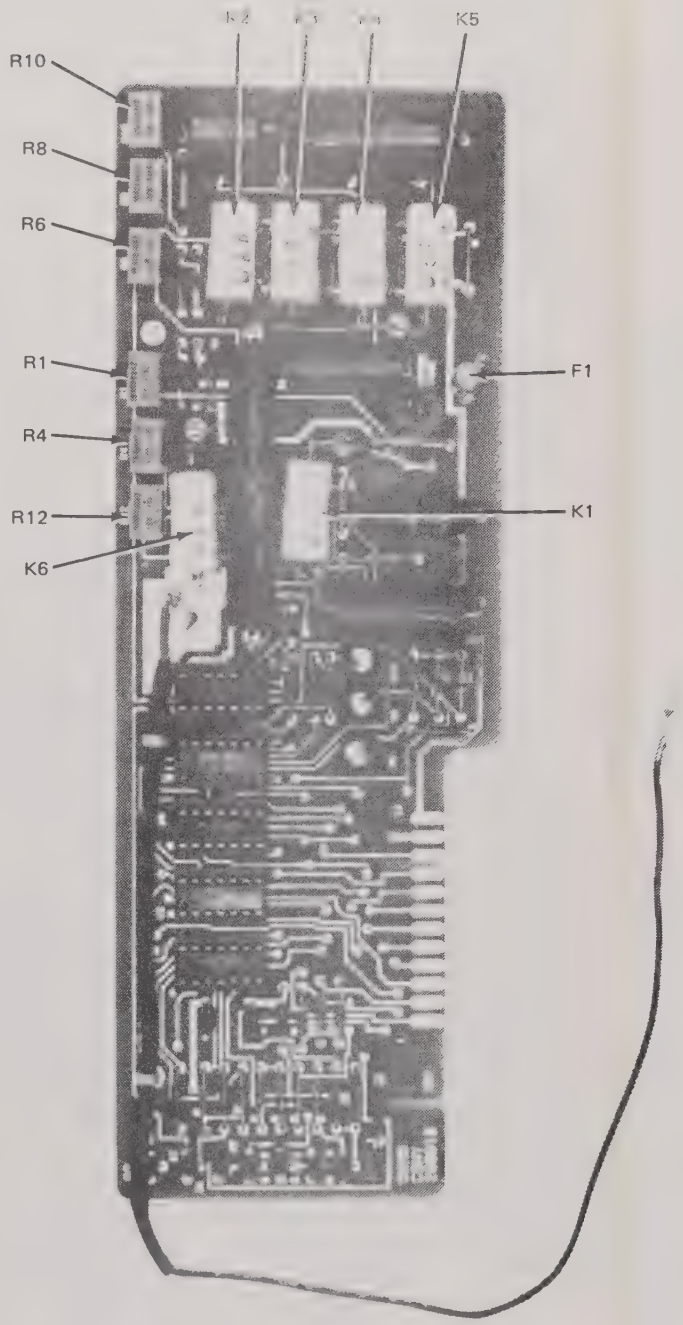
A1
POWER SUPPLY
DRAWING NO 8200A-1001 REV b

MODEL 8200A
TROUBLESHOOTING PROCEDURE

1. Connect each of the resistors in Table 4, in turn, to the INPUT terminals and note readings.

FAULT ANALYSIS

If readings do not correspond, fault could be individual range adjustments, logic circuitry, resistor network or +7V reference voltage. Check +7V between A7TP2 (+7V) and A7TP1 (common) on assembly A7 using differential voltmeter. Voltage should be 7.0000V ±100μV.



TEST EQUIPMENT REQUIRED

Resistor Standards
100Ω ±0.03%
1KΩ±0.03%
10KΩ±0.03%
100KΩ±0.03%
1MΩ±0.03%
10MΩ±0.1%

RELAY	MODEL 8200A FUNCTION AND RANGE					
	100Ω	1KΩ	10KΩ	100KΩ	1000KΩ	10MΩ
K1				o	o	
K2				o		
K3		o	o			
K4		o				
K5	o					
K6	o	o	o	o	o	o
o Denotes Relay Energized						

Table 1. OHMS CONVERTER RELAY LOGIC

RANGE	$\bar{a}$	$\bar{b}$	a	b
1	1	1	0	0
10	1	0	0	1
100	0	1	1	0
1000	0	0	1	1
LOGIC "1" = +5V LOGIC "0" = 0V				

Table 2. RANGE CODE

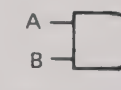
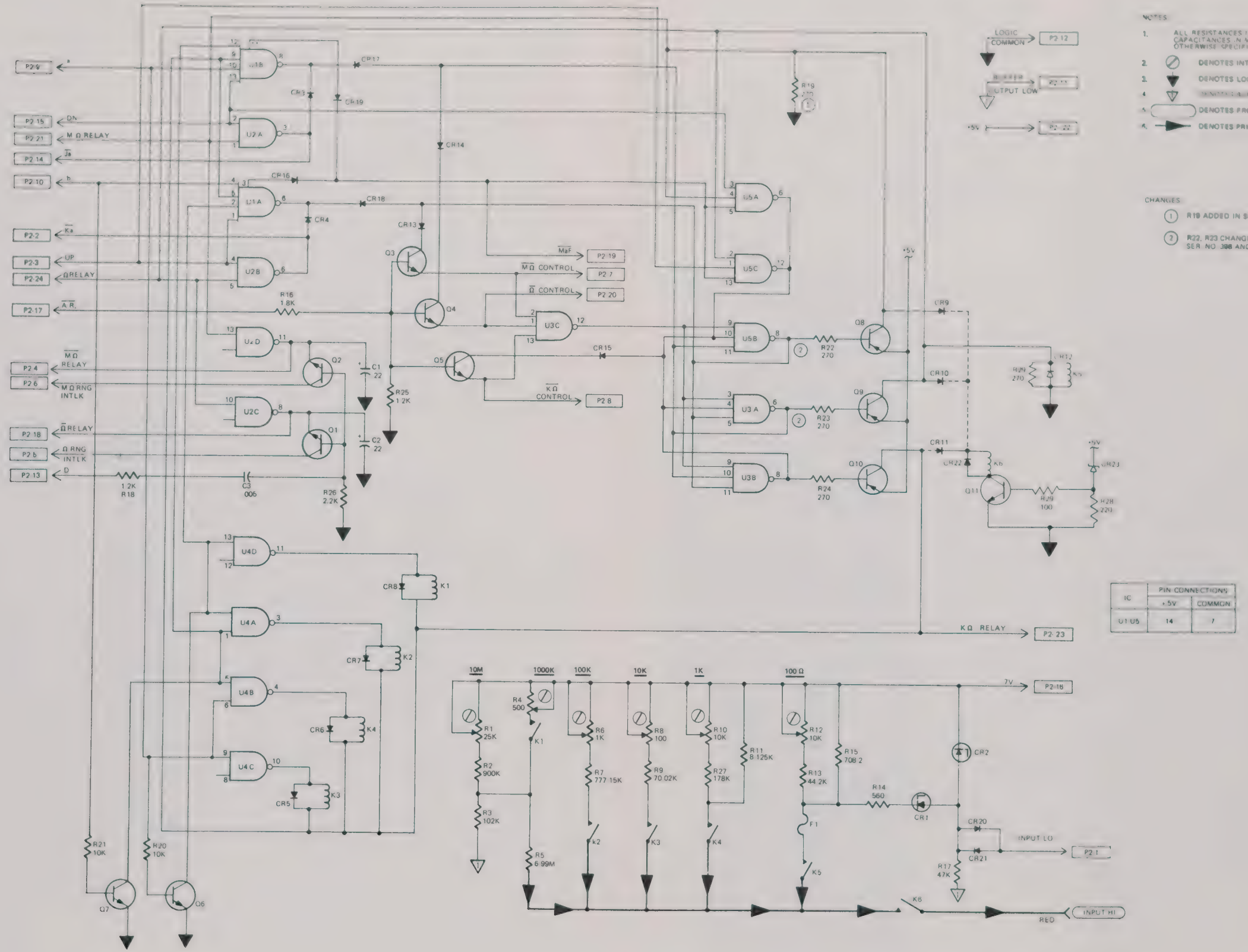
SYMBOL	A	B	C
	0	0	1
	0	1	1
	1	0	1
	1	1	0
LOGIC LEVELS: "1" = High (+5V) "0" = Low (0V)			
Operation is identical for gates having additional inputs.			

Table 3. NAND GATE TRUTH TABLE

RESISTANCE	MODEL 8200A		
	RANGE	FUNCTION	READOUT
10MΩ ±0.1%	10	MΩ	9.988 to 10.012
1MΩ ±0.03%	1000	KΩ	999.6 to 1000.4
100KΩ ±0.03%	100	KΩ	99.98 to 100.02
10KΩ ±0.03%	10	KΩ	9.989 to 10.011
1KΩ ±0.03%	1	KΩ	.9899 to 1.0101
100Ω ±0.03%	100	Ω	99.95 to 100.05

Table 4. CALIBRATION CHECK

A2
Ohms Converter Troubleshooting Procedure
Drawing No. 8200A-1802



IC	PIN CONNECTIONS	
	+5V	COMMON
U1-U5	14	7

A2
OHMS CONVERTER
DRAWING NO. 8200A-1002 REV 4

MODEL 8200A
TROUBLESHOOTING PROCEDURE

1. Depress MVDC, FILTER and AUTO buttons on Model 8200A and visually center the front panel MV ZERO control.
2. Connect a shorting jumper across the INPUT terminals. The Model 8200A should autorange to the 10MV range (if not already there) and the readout should be ±0.000 ±2 digits.

FAULT ANALYSIS

If readout is greater than ±2 digits, coarse control A3R15 (MV ZERO) may have to be adjusted. If unable to adjust A3R15 for proper readout, the amplifier section may be faulty.

NOTE

Resistors R39 and R40 are offset correction resistors which are selected at the factory. If transistor Q3 and /or amplifier U6 are replaced, the offset of the MV Converter must be checked. Refer to Resistor Selection procedure on this drawing.

3. Connect equipment as shown in Figure 1.

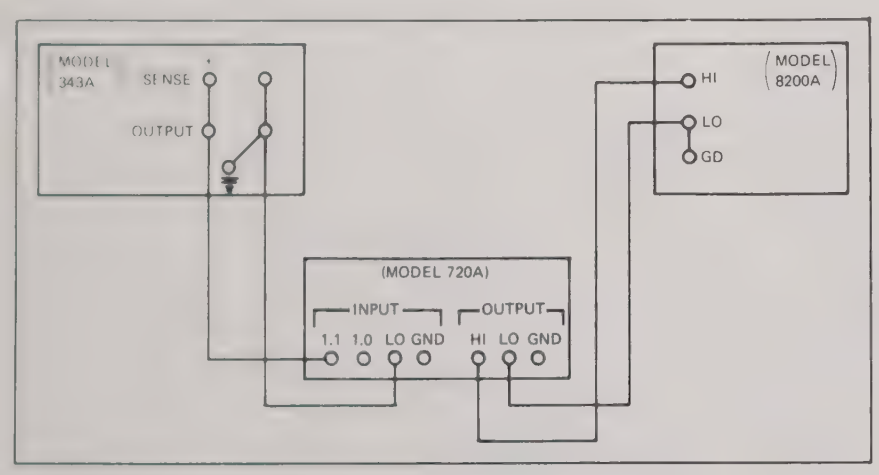


Figure 1. EQUIPMENT CONNECTION

4. Remove jumper and apply +4MV dc to Model 8200A Input terminals as follows:
   a. Set Model 343A to +1.1Vdc output.
   b. Dial .0040000 on Model 720A.

   Model 8200A readout should be +4.000 and it should be in MVDC function.

FAULT ANALYSIS

Problems encountered in steps 2 through 4 can be caused by logic control circuitry, or divider string R24 through R29.

5. Apply +104MV, +204MV, +104MV, +4MV to the Model 8200A, in turn, by setting Model 720A dials to .1040000, .2040000, .1040000 and .0040000 respectively. The Model 8200A should uprange to 100MV range, then to 1V range, then downrange through the 100MV range to the 10MV range.

FAULT ANALYSIS

If problems are encountered in step 5, probable cause is logic control circuitry.

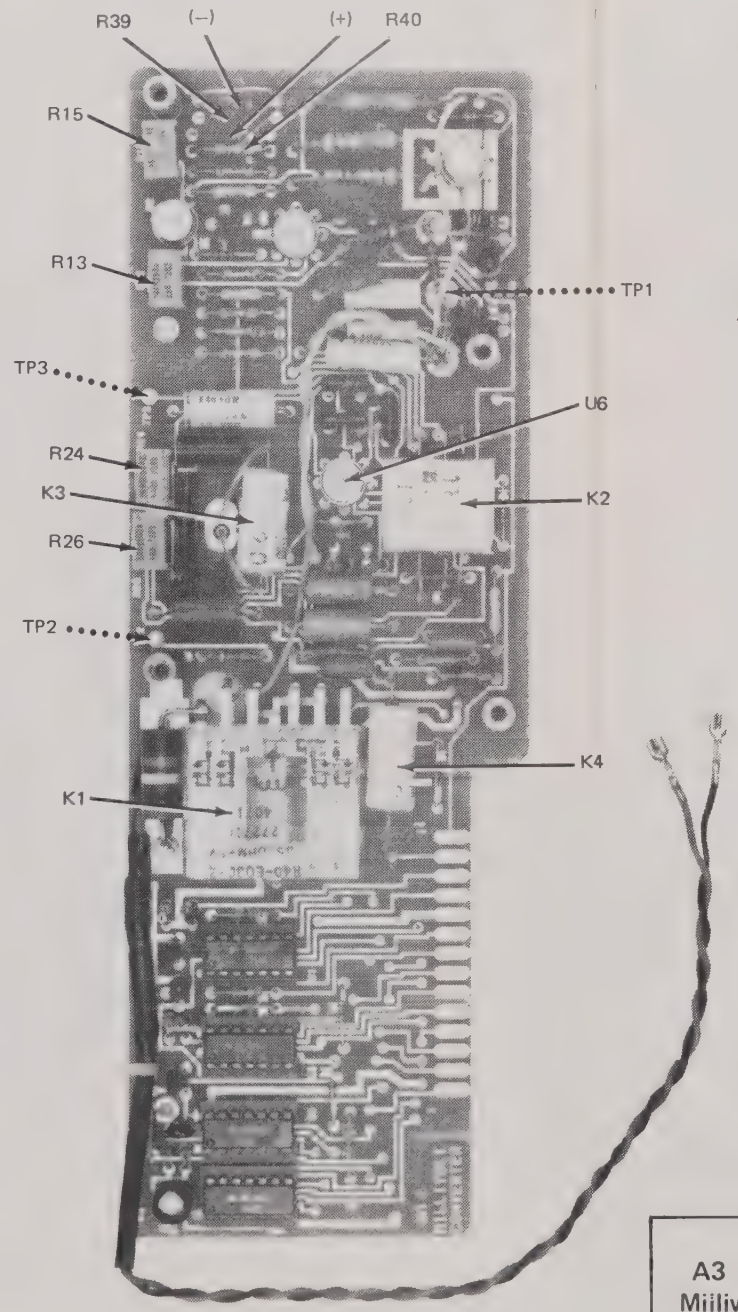
6. Short INPUT terminals and adjust front panel MV ZERO control, if necessary, for 0.000 ±2 digits.
7. Remove short and connect a shielded 1MΩ, 5%, 1/4 watt resistor shunted by a 0.1uF polystyrene or polycarbonate capacitor across INPUT terminals. Readout should be 0.000 ±2 digits, allowing several seconds for reading to

FAULT ANALYSIS

If proper readout is not obtained, check adjustment of A3R13 (MV BIAS CURRENT). If unable to adjust for proper readout, check Q3.

RESISTOR SELECTION PROCEDURE

1. Connect a shorting clip from INPUT LO to TP1 (R3, C2, and R4 Teflon standoff).
2. Connect jumper wires across R39 and R40 positions marked "+" and "–" (located below R15) and remove existing R39 or R40 resistors if installed.
3. Visually set front panel MV ZERO pot and A3R15 to middle of range.
4. Turn 8200A on and note readout.
5. Using Table 4, select a resistor corresponding to the readout or Offset Voltage.



6. Turn instrument off. If reading was positive (+), install resistor R40 in "+" space; if negative (–), install resistor R39 in "–" space. Remove jumper wire adjacent to newly installed resistor.
7. Turn instrument on. Readout should be less than ±100 digits in 10MV range. If it is not, examine offset correction resistor for correct value and location and correct if necessary.
   a. If original offset was undercompensated for (reading of same polarity but greater than 100 digits), replace offset correction resistor with next larger value in Table 4. If over 300 digit offset, replace Q3.
   b. If original offset was overcompensated (changes sign and greater than 100 digits), replace offset correction resistor with next smaller value in Table 4. If over 300 digit offset, replace Q3.

RELAY	MODEL 8200A RANGE	
	10MV	100MV
K1	o	o
K2	(Energized in FILTER Function)	
K3		o
K4	o	o
o Denotes Relay Energized		

Table 1. MILLIVOLT CONVERTER RELAY LOGIC

SYMBOL	A	B	C
A, B → C	0	0	1
	0	1	1
	1	0	1
	1	1	0
LOGIC LEVELS: "1" = High (+5V), "0" = Low (0V)			
Operation is identical for gates having additional inputs.			

Table 2. NAND GATE TRUTH TABLE

TEST EQUIPMENT REQUIRED

Equipment Nomenclature	Recommended Equipment
Voltage Calibrator	FLUKE Model 343A
Voltage Divider	FLUKE Model 720A

RANGE	$\bar{a}$	$\bar{b}$	a	b
1	1	1	0	0
10	1	0	0	1
100	0	1	1	0
1000	0	0	1	1
LOGIC "1" = High (+5V)				
LOGIC "0" = Low (0V)				

Table 3. RANGE CODE

OFFSET VOLTAGE CORRECTION RESISTORS

READOUT (OFFSET VOLTAGE)	ADD RESISTOR	J. F. PART NO.
0000-0100	None	
0101-0200	6.98k	261685
0201-0400	21.5k	289470
0401-0600	35.7k	28848[illegible]
0601-0800	51.1k	28955[illegible]
0801-1000	64.9k	288530
1001-1200	80.6k	281121
1201-1400	95.3k	289561
1401-1600	110k	234708
1601-1800	124k	288407
1801-2000	140k	289439
2001-2200	154k	289447
2201-2400	169k	289454
2401-2600	187k	289462
2601-2800	200k	261701
2801-3000	215k	289470
3001-3200	232k	276618
3201-3400	249k	268805
3401-3600	267k	289090
3601-3800	280k	235267
3801-4000	301k	289488
4001-4200	316k	289496
4201-4400	332k	289504
4401-4600	348k	289512
4601-4800	365k	289520
4801-5000	383k	288498

Table 4. OFFSET VOLTAGE CORRECTION RESISTORS

A3
Millivolt Converter Troubleshooting Procedure
Drawing No. 8200A-1803

A3
MILLIVOLT CONVERTER
DRAWING NO. 92004-1003 REV A

NOTES
1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

CHANGES
(1) MOVED AND CHANGED VALUE OF C12 FROM 0.22 TO 2.2 IN 9&M NO. 44& AND ON

1. DENOTES INTERNAL ADJUSTMENT.
2. DENOTES LOGIC COMMON.
3. DENOTES BUFFER OUTPUT LOW.
4. DENOTES FRONT PANEL LOCATION.
5. FACTORY SELECTED RESISTOR.
6. DENOTES PRIMARY SIGNAL PATH.

PIN CONNECTIONS		
IC	+5V	COMMON
U1 U4	14	7

+5V
-15V
+15V
LOGIC GND
BUFFER OUTPUT LOW
MV ZERO
BUFFER RETURN
POLARITY
VO
VDC RELAY
MV RELAY
MVDC CONTROL
VDC CONTROL
AR
MAF
UP
DOWN
VDC RELAY
MV SENSE RANGE
MV BIAS CURRENT
INPUT
HI
LO

MODEL 8200A
TROUBLESHOOTING PROCEDURE

1. Set the Model 8200A controls as follows:

   FUNCTION VCD
   RANGE 1

2. Jumper A6TP2 to A6TP3 (Logic Control Assembly) for continuous measure cycle.

3. Connect shorting jumper across INPUT terminals and observe readout. There should be a uniform alternation between the + and – signs in the display and readout should be .0000 ±1 digit.

FAULT ANALYSIS

If readout does not correspond, adjust A4R22 (VDC ZERO) for correct readout. If unable to obtain desired readout, the probable cause is the amplifier section.

4. Apply + and – 1.5995Vdc to INPUT terminals of Model 8200A and note that the readout is + and – 1.5995 ±1 digit.

5. Apply + and – 10Vdc to INPUT terminals of Model 8200A.

6. Connect voltmeter LO to A4TP3 and HI to A4TP2 and note that voltmeter reads + and – 2.5 ±0.5Vdc.

FAULT ANALYSIS

If readings do not correspond, the probable cause is in the overload circuitry. The amplifier section may be a secondary cause.

7. Remove jumper between A6TP2 to A6TP3.

8. Depress AUTO button and apply +11, +110 and +1100 volts, in turn, to INPUT terminals. Readouts should be +11.000, +110.00 and +1100.0 (±1 digit) respectively.

FAULT ANALYSIS

If readings do not correspond, check calibration adjustments A4R3 (10VDC), A4R5 (100VDC) and A4R7 (1000VDC) respectively. If still not correct, check input divider circuitry.

9. Remove voltage inputs.

10. Press Ω, 100 RANGE and FILTER buttons. Readout should be 159.99 with open INPUT and less than 00.50 with shorted INPUT.

11. Press KΩ button. Readout should be 159.99 with open INPUT and less than 00.02 with shorted INPUT.

12. Press MΩ and 10 RANGE buttons. Readout should be 15.999 with open INPUT and less than 0.002 with shorted INPUT.

FAULT ANALYSIS

If readings are not correct in steps 9 through 12, check logic circuitry on Buffer Assembly.

13. Jumper A6TP2 to A6TP3 and depress FILTER switch.

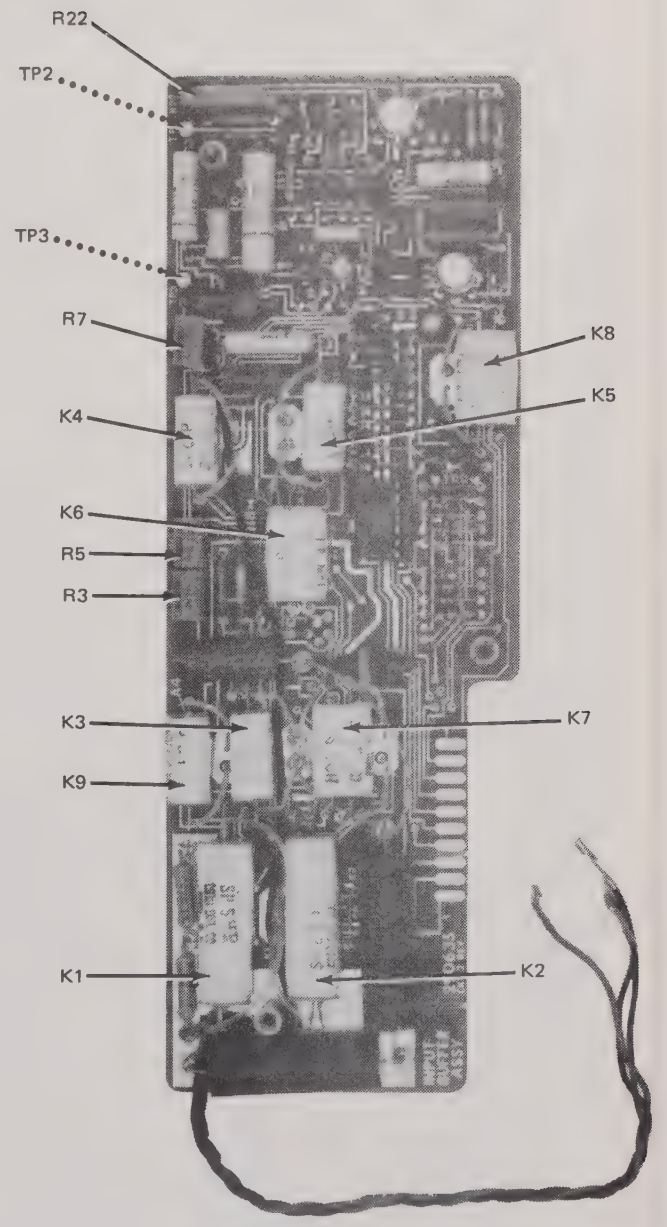
14. Apply +.10055Vdc to INPUT terminals.

15. Decrease input voltage in steps of 10μV until the last digit in the display is a steady 5. Note input voltage.

16. Increase input voltage in steps of 10μV until the last digit in the display is a steady 6. Note input voltage. The difference between inputs in step 15 and 16 should be less than 60μV.

FAULT ANALYSIS

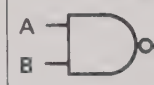
If readings do not correspond, probable cause is the FILTER circuitry.



A4
Input Buffer
Drawing No. 8200A-1804

TEST EQUIPMENT REQUIRED

Equipment Nomenclature	Recommended Equipment
Voltage Calibrator	FLUKE Model 343
Digital Voltmeter	FLUKE Model 8100

SYMBOL	A	B	C
	0	0	1
	0	1	1
	1	0	1
	1	1	0

LOGIC LEVELS: "1" = High (+5V)
"0" = Low (0V)

Table 1. NAND GATE TRUTH TABLE

RANGE	$\overline{a}$	$\overline{b}$	a	b
1	1	1	0	0
10	1	0	0	1
100	0	1	1	0
1000	0	0	1	1

LOGIC LEVEL "1" = High (+5V)
"0" = Low (0V)

Table 2. RANGE CODE

MODEL 8200A
TROUBLESHOOTING PROCEDURE

1. Depress VAC and range 1 buttons.
2. Connect 8100A voltmeter HI to A5TP3 and LO to INPUT LO.
3. Connect shorting jumper across INPUT terminals.
4. Observe that external voltmeter reads less than ±15mV.

FAULT ANALYSIS

If reading does not agree, check operational rectifier circuitry.

5. Remove shorting jumper and apply 10VAC at 500Hz to INPUT (X10 overload). Verify external voltmeter reads same as in step 4 (±5mV).

FAULT ANALYSIS

If reading is not correct, check adjustment A5R31 (SYMMETRY) and check Q2 through Q5, CR9 and CR10.

6. Connect scope in place of external voltmeter.
7. Reduce input to 1.6 volts, then increase input until clipping first occurs. Input should be 1.7 volts or more before any clipping. An additional 0.1 volt increase should cause symmetrical clipping on both sides.

FAULT ANALYSIS

If clipping occurs below 1.7V or is asymmetrical, check operational rectifier circuitry and check A5R31 adjustment (SYMMETRY).

8. Set to 1000 volt range and apply 10V at 500Hz to INPUT. Readout should be 010.0 ± 1 digit.
9. Remove signal, short INPUT and set to RANGE 1. Readout should be .0001 ±5 digits.

FAULT ANALYSIS

If unable to obtain readings in steps 8 and 9, check adjustment of R48 and check DC difference amplifier/integrator circuitry.

10. Using AC Calibration system, apply signals shown in Table 4, in turn, to INPUT. Readouts should be as indicated.

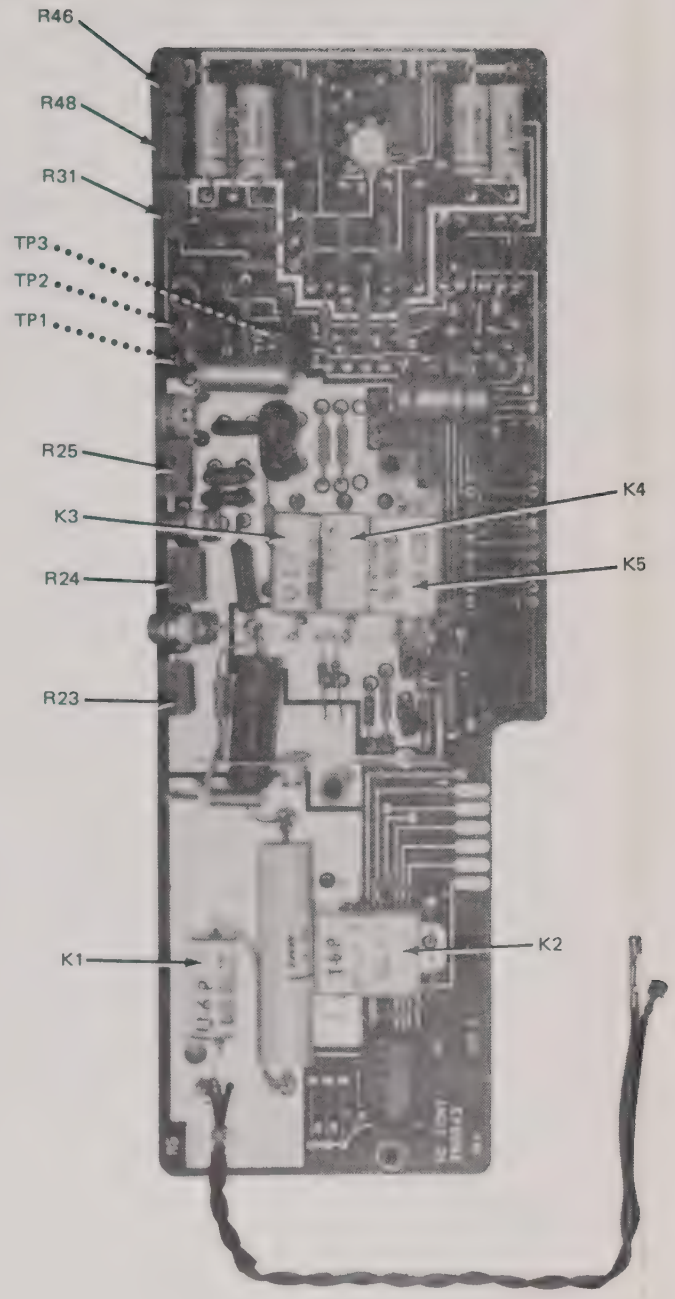
FAULT ANALYSIS

If unable to obtain desired readings, check adjustments and operational rectifier circuitry.

11. Connect scope HI to A5TP2 and LO to INPUT LO and set 8200A to 1 RANGE.
12. Apply 1V at 50Hz to INPUT. Ripple on scope should not exceed 2.5mV peak-to-peak.

FAULT ANALYSIS

If ripple exceeds 2.5V peak-to-peak, check DC difference amplifier/integrator circuitry.



TEST EQUIPMENT REQUIRED

Equipment Nomenclature	Recommended Equipment
AC Calibrator	H. P. Model 745
Digital Voltmeter	FLUKE Model 810
Oscilloscope	Tektronix Model 50

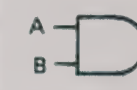
SYMBOL	A	B	C
	0	0	1
	0	1	1
	1	0	1
	1	1	0
LOGIC LEVELS: "1" = High (+5V) "0" = Low (0V)			

Table 1. NAND GATE TRUTH TABLE

RANGE	$\overline{a}$	$\overline{b}$	a	b
1	1	1	0	0
10	1	0	0	1
100	0	1	1	0
1000	0	0	1	1
LOGIC LEVEL: "1" = High (+5V) "0" = Low (0V)				

Table 2. RANGE CODE

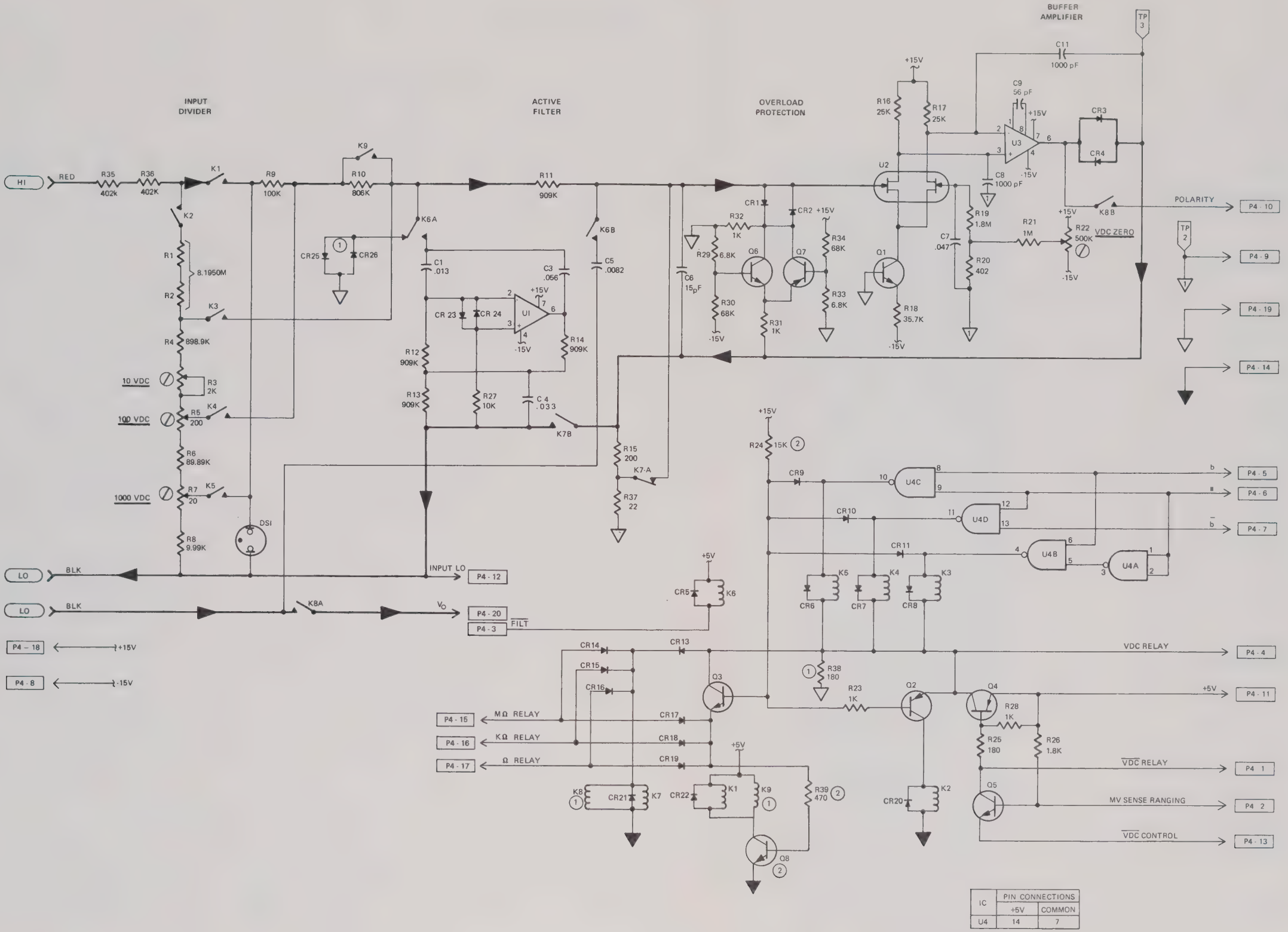
RELAY	MODEL 8200A RANGE 1	10	100	1000
K1	o	o	o	o
K2	o	o	o	o
K3		o		
K4			o	
K5				o
oDenotes Relay Energized				

Table 3. A5 AC CONVERTER RELAY LOGIC

Model 8200A					
Input					
Voltage	Frequency	Range	Adjustment	Circuit Designation	Readout (±5 digits)
500.0	400Hz	1000	1000VAC 500Hz	R46	500.0
1.0000	400Hz	1	1VAC 500Hz	R23	1.0000
10.000	400Hz	10	10VAC 500Hz	R24	10.0
100.00	400Hz	100	100VAC 500Hz	R25	100.

Table 4. CALIBRATION CHECK

A5
AC Converter Troubleshooting Procedure
Drawing No. 8200A-1805



NOTES:

1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ⊘ DENOTES INTERNAL ADJUSTMENT.
3. ▽ DENOTES BUFFER RETURN.
4. ▽ DENOTES BUFFER OUTPUT LOW.
5. ⬭ DENOTES FRONT PANEL LOCATION.
6. ▼ DENOTES LOGIC COMMON.
7. → DENOTES PRIMARY SIGNAL PATH.

CHANGES:

(1) R38, CR25, CR26, K8 and K9 added in Ser. No. 329 and on.

(2) R39, Q 8 ADDED AND R24 CHANGED FROM 10K IN SER. NO. 580 AND ON.

(3) C9 CHANGED FROM 68PF AND C8 CHANGED FROM 390PF AT SERIAL NO. 620 AND ON.

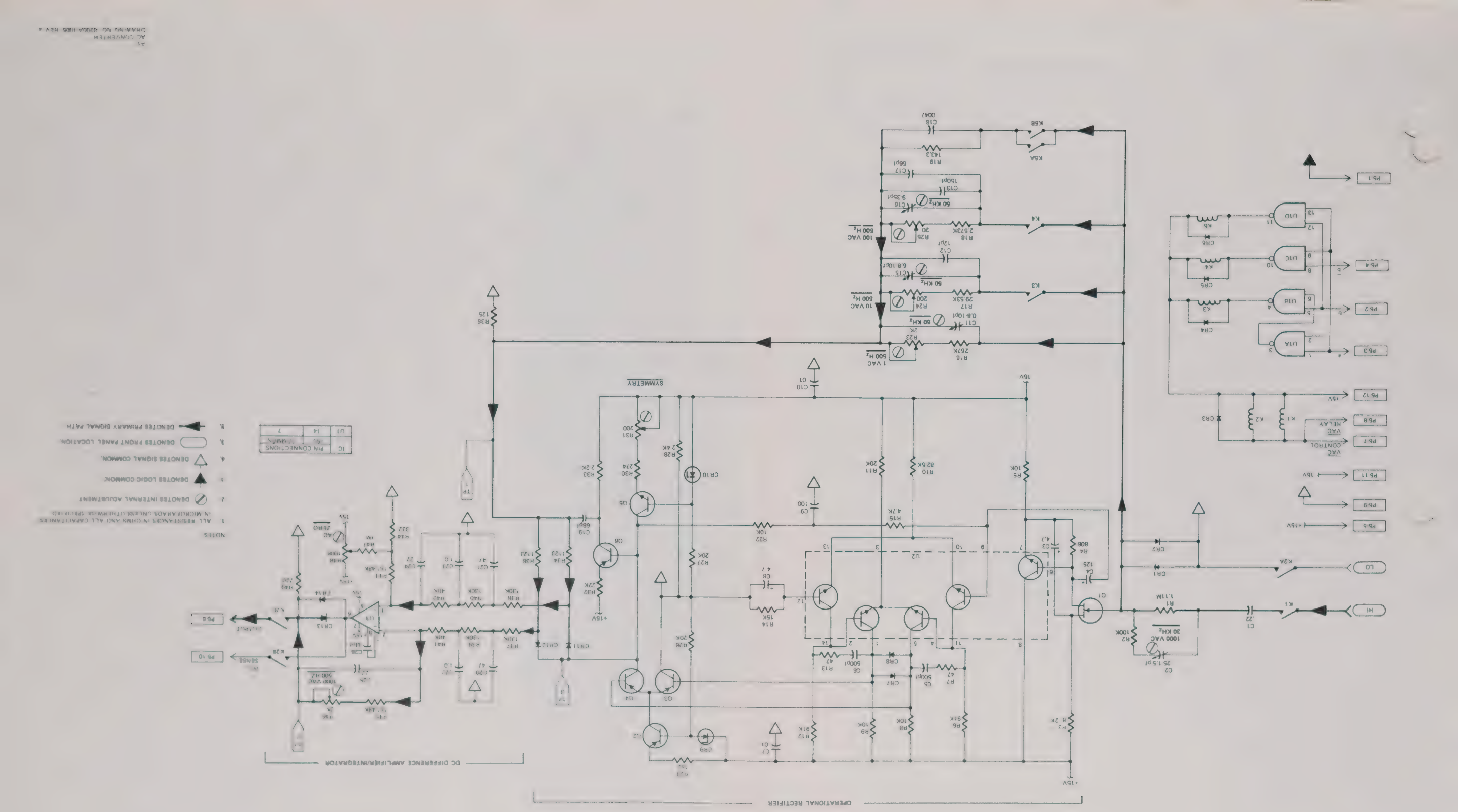
RELAY	VOLTAGE RANGE				FILTER
	1	10	100	1000	
K1	•				
K2		•	•	•	
K3		•			
K4			•		
K5				•	
K6					•
K7	•	•	•	•	
K8	•	•	•	•	
K9	•				

• DENOTES RELAY ENERGIZED

IC	PIN CONNECTIONS	
	+5V	COMMON
U4	14	7

A4
INPUT BUFFER ASSEMBLY
DRAWING NO 8200A 1004 REV a

A2
AC CONVERTER
DRAWING NO. 92004-1006 REV A



MODEL 8200A
TROUBLESHOOTING PROCEDURE

1. Connect scope to A6TP4 and ground (A6TP2) and observe $\overline{H}$ signal. It should appear as shown in Figure 1A with equally spaced pulses occurring five times per cycle.
2. Increase scope sweep speed to obtain waveform shown in Figure 1B.

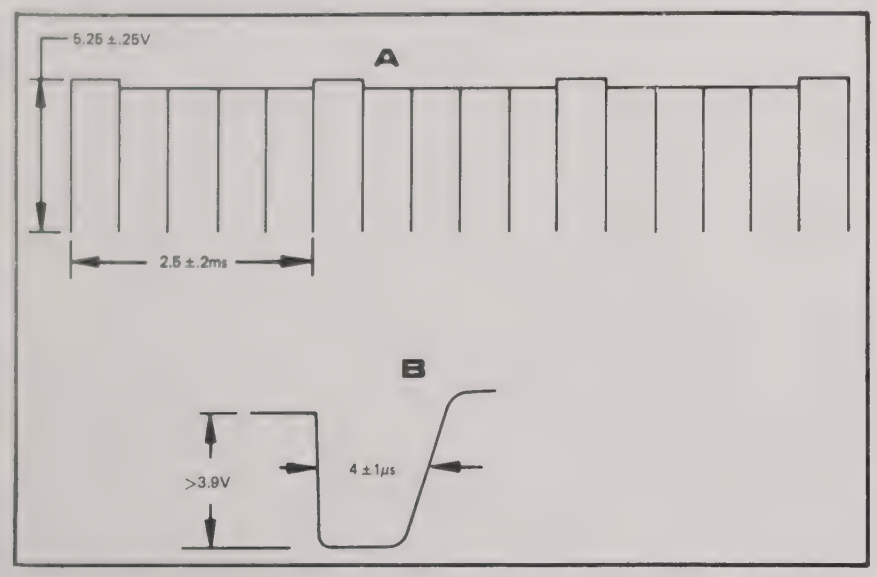


Figure 1. $\overline{H}$ SIGNAL

FAULT ANALYSIS

If signal requirements are not met, check master clock, U1B and Q2.

3. Connect scope to A6TP5 and ground (A6TP2) and observe the M signal. It should appear as shown in Figure 2.

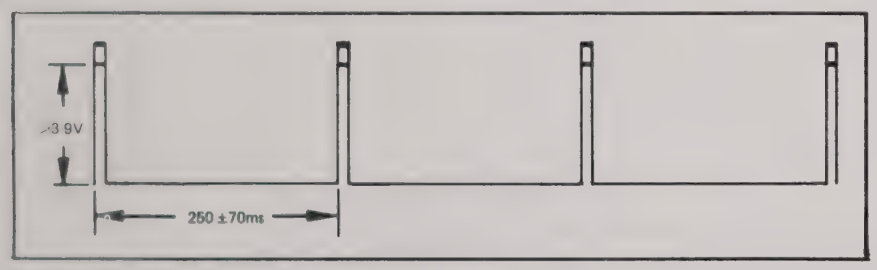


Figure 2. M SIGNAL

FAULT ANALYSIS

If signal requirements are not met, check U1A, Sample Oscillator, Shift Register and U4B.

4. Remove oscilloscope connections and press VDC, RANGE 1 and FILTER buttons.
5. Apply +10 volts dc to the INPUT. Display should be a steady +1.5999.
6. Apply +0.1005, +0.2005, +0.4005 and +0.8005 volts, in turn, to the INPUT. Verify corresponding readouts ±2 digits in least significant digit.

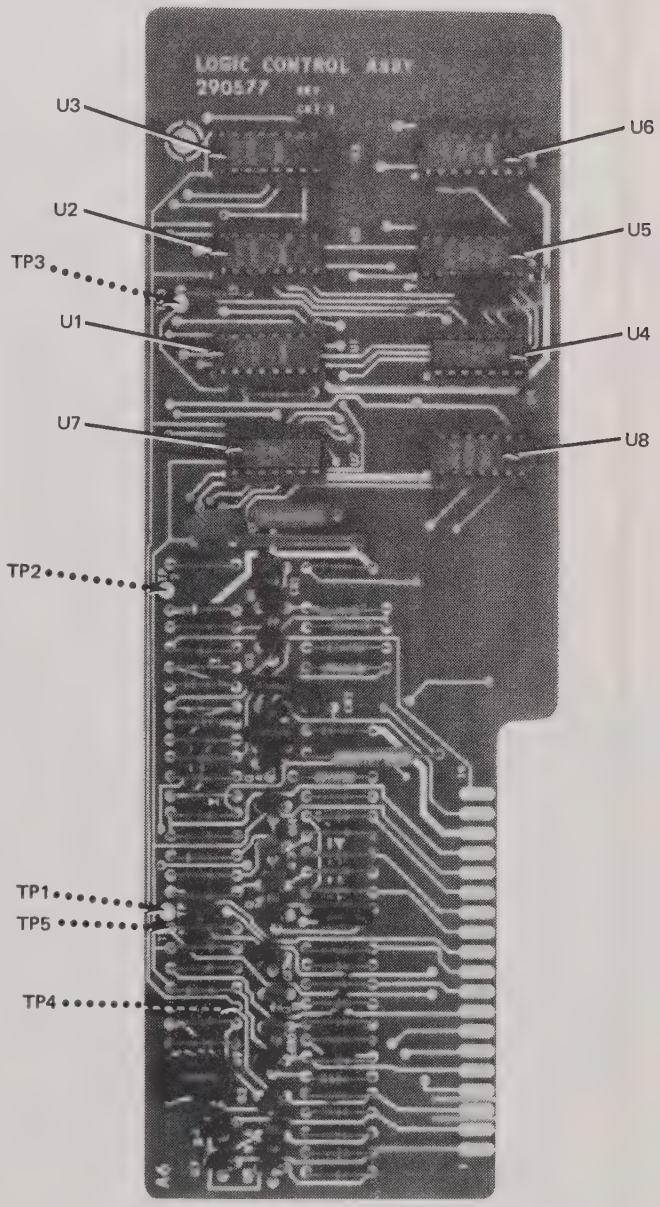
FAULT ANALYSIS

If proper readings are not obtained in steps 5 and 6, check Counter and Current Controlled Oscillator circuits.

7. Press VDC, AUTO and FILTER buttons.
8. Apply +0.09050 volts to INPUT. Readout should be +90.50 ±3 digits and MVDC lamp should be on.
9. Increase input voltage in 0.01 volt steps until input is +0.15050. At this point, 8200A should autorange, readout should be +.1505 ±3 digits and VDC lamp should be on.
10. Decrease input voltage in 0.01 volt steps until input is +0.09050 volts. At this point, 8200A should autorange, readout should be +90.50 ±3 digits and MVDC lamp should be on.

FAULT ANALYSIS

If proper results are not obtained in steps 8 through 10, check autorange circuitry.



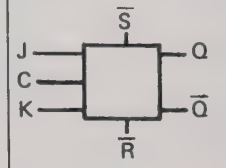
TEST EQUIPMENT REQUIRED

Equipment Nomenclature	Recommended Equipment
Voltage Calibrator	FLUKE Model 343A
Oscilloscope	Tektronix Model

SYMBOL	A	B	C
	0	0	1
	0	1	1
	1	0	1
	1	1	0

LOGIC LEVELS: "1" = High (+5V)
"0" = Low (0V)

Table 1. NAND GATE TRUTH TABLE

SYMBOL	SYNCHRONOUS INPUTS		
	J	K	Q_{nt1}
	0	0	Q_n
	0	1	0
	1	0	1
	1	1	$\overline{Q}_n$

ASYNCHRONOUS INPUTS			
$\overline{S}$	$\overline{R}$	Q	$\overline{Q}$
0	0	Undefined	
0	1	1	0 (set)
1	0	0	1 (reset)
1	1	Normal conditio	

Table 2. J-K FLIP FLOP TRUTH TABLES

A6
Logic Control Assembly Troubleshooting Procedure
Drawing No. 8200A-1806

MODEL 8200A
TROUBLESHOOTING PROCEDURE

1. Connect 8100A to test points A7TP2 and A7TP1 (ground). External Voltmeter should read +7.000 ±0.001 volts.

FAULT ANALYSIS

If unable to obtain proper voltage, check +7V reference adjustment and supply.

2. Remove external voltmeter connections and jumper A6TP2 and A6TP3 together (Logic Control Assembly). Jumper should remain in place until last check.
3. Press VDC, RANGE 1 and FILTER buttons.
4. Connect scope high to A7TP3 with scope low connected to INPUT LO. Set scope controls for 2V/Div and 0.5ms/Div. Sync scope with A6TP1 signal.
5. Apply input for steady +1.0005 readout. Waveform should be similar to that shown in Figure 1 and should not exceed indicated amplitude.
6. Delay trace A to display ramp shown in Figure 1 at 10μs/Div. Time required for voltage to rise from 1 volt level to upper limit (Figure 2) should not be more than 20μs.

FAULT ANALYSIS

If ramp is more than 20μs long, replace C8 (33pF) with 15pF capacitor If still more than 20μs long, replace U2 and re-install 33pF capacitor.

7. Disconnect scope and apply −0.00055V to INPUT. The last digit should flicker uniformly between "5" and "6".
8. Repeat step 7 for +0.00055V input.

FAULT ANALYSIS

If proper indications are not obtained in steps 7 and 8, check ladder circuit and adjustment of R27 and R38 respectively.

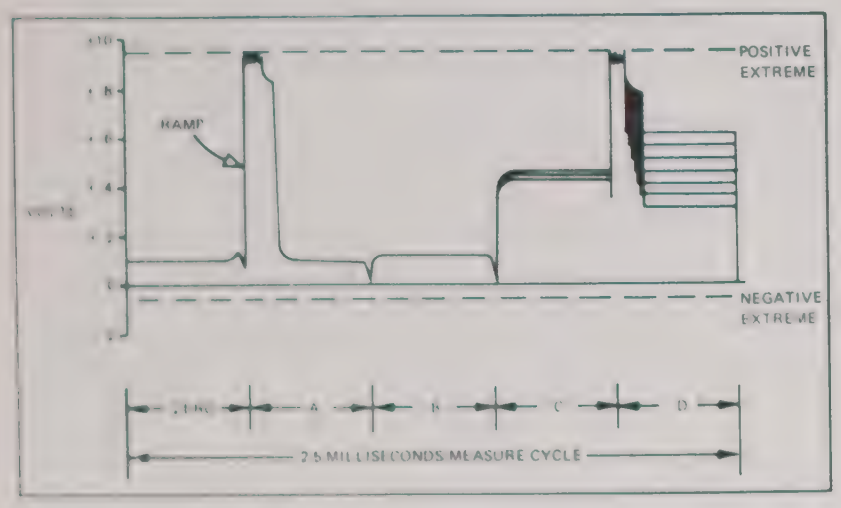


Figure 1. A/D MEASURE CYCLE

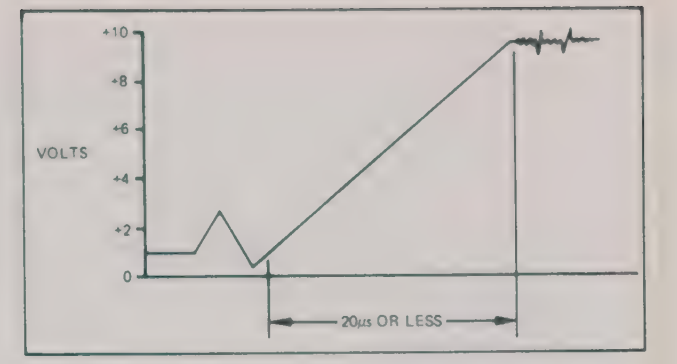
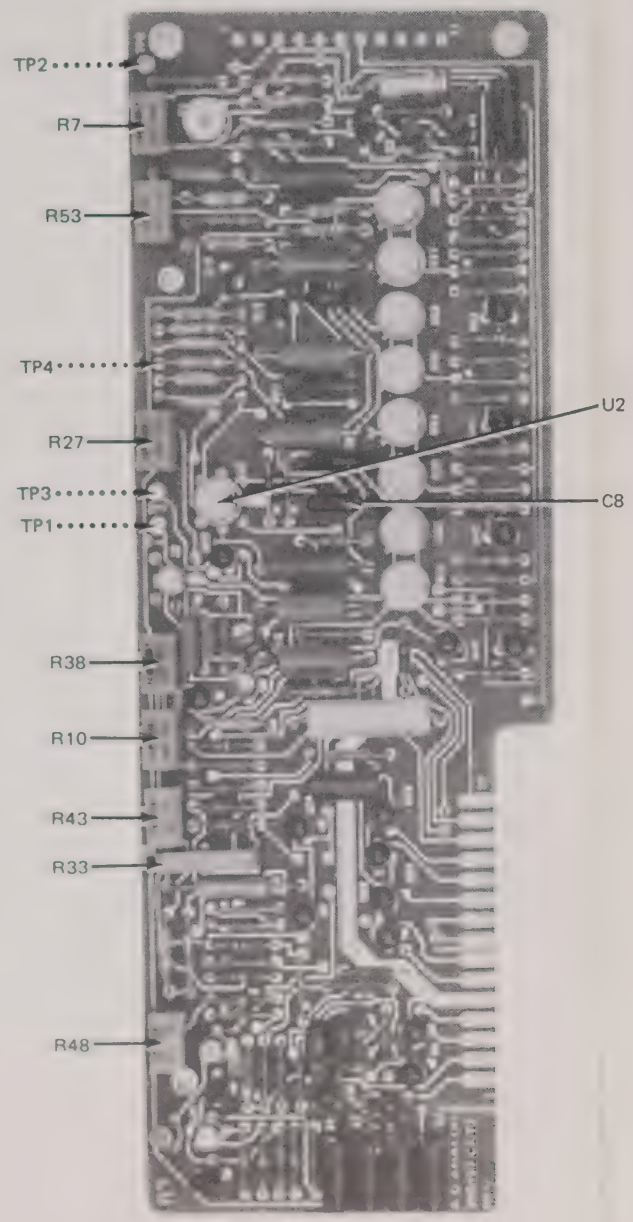


Figure 2. SLEW RATE MEASUREMENT



9. Apply +0.70055V to INPUT. Readout should be +.700X where "X" flickers between "5" and "6".

FAULT ANALYSIS

If proper indication is not obtained, check adjustment of R10 and associated circuitry.

10. Apply +0.80055V to INPUT. Readout should be +.800X where "X" flickers between "5" and "6".

FAULT ANALYSIS

If proper indication is not obtained, check adjustment of R53 and associated circuitry.

11. Apply −0.70055V to INPUT. Readout should be −.700X where "X" flickers evenly between "5" and "6".

FAULT ANALYSIS

If proper indication is not obtained, check adjustment of R33 and associated circuitry.

12. Apply +0.09955V to INPUT. Readout should be +.099X where "X" flickers between "5" and "6".

FAULT ANALYSIS

If proper indication is not obtained, check adjustment of R43 and associated circuitry.

13. Apply −0.09955V to INPUT. Readout should be −.009X where "X" flickers between "5" and "6".

FAULT ANALYSIS

If proper results are not obtained, adjust input voltage in 10μV steps until the "5" and "6" flickers evenly: Applied voltage should then be −0.09955V ±0.00002V. If not, check adjustment of R38 and R27.

14. Apply +0.09995V to INPUT. Readout should flicker uniformly between .0999 and .1000.

FAULT ANALYSIS

If proper results are not obtained, check adjustment of R48 and associated circuitry.

TEST EQUIPMENT REQUIRED

Equipment Nomenclature	Recommended Equipment
Voltage Calibrator	FLUKE Model 343A
Oscilloscope	Tektronix Model 2[illegible]
Voltmeter	FLUKE Model 81[illegible]

A7
A/D Converter Troubleshooting Procedure
Drawing No. 8200A-1807

PIN CONNECTIONS		
IC	+5V	COMMON
U7, U4	14	7
U1, U2, U3, U5, U6	16	8
U8	8	1

NOTES:
1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ▲ DENOTES LOGIC COMMON.

CHANGES
① C9 ADDED IN SER. NO. 438 AND ON.

MODEL 8200A
TROUBLESHOOTING PROCEDURE

1. Apply +5V power to Pins 4 and 2 (ground) of RCU connector, A8P13.

NOTE

Following tests assume a fully-loaded Model 8200A (all options installed).

2. Short INPUT terminals and press REMOTE button. Model 8200A should autorange to 10 RANGE and autofunction to MVDC.
3. Call functions and ranges listed in Table 3 by connecting the appropriate pin to ground (Pin 2) of connector P13. Model 8200A range and function indicators should agree.

FAULT ANALYSIS

If instrument does not respond properly to called functions, isolate problem by checking F, G, H, J, K, L, N and R "signals" from input circuitry through guard to guarded circuitry.

4. Leave INPUT terminals shorted and call 1000 RANGE, VDC and FILTER. Release range command and verify instrument sequentially autoranges down to RANGE 1 and autofunctions to MVDC.
5. Repeat step 3 with VAC called instead of VDC. Verify sequential autorange down to RANGE 1.
6. Call 1000 RANGE, KΩ and FILTER with INPUT terminals open. Release range command and verify instrument indicates 10MΩ and FILTER.
7. Short INPUT and verify instrument sequentially autoranges and autofunctions from 10MΩ through all four KΩ ranges to 100Ω range.
8. Remove short from INPUT. Indications observed in step 6 should reverse.

FAULT ANALYSIS

If proper indications are not obtained in steps 3 through 7, check associated circuitry on both sides of guard.

9. Call FILTER
10. Call AUTO COMMAND ENTRY DEFEAT (Pin 27).
11. Call FILTER. Instrument should remain in FILTER mode.
12. Remove AUTO COMMAND ENTRY DEFEAT input (Pin 27). Instrument should indicate 10 RANGE, VDC and MVDC without FILTER.

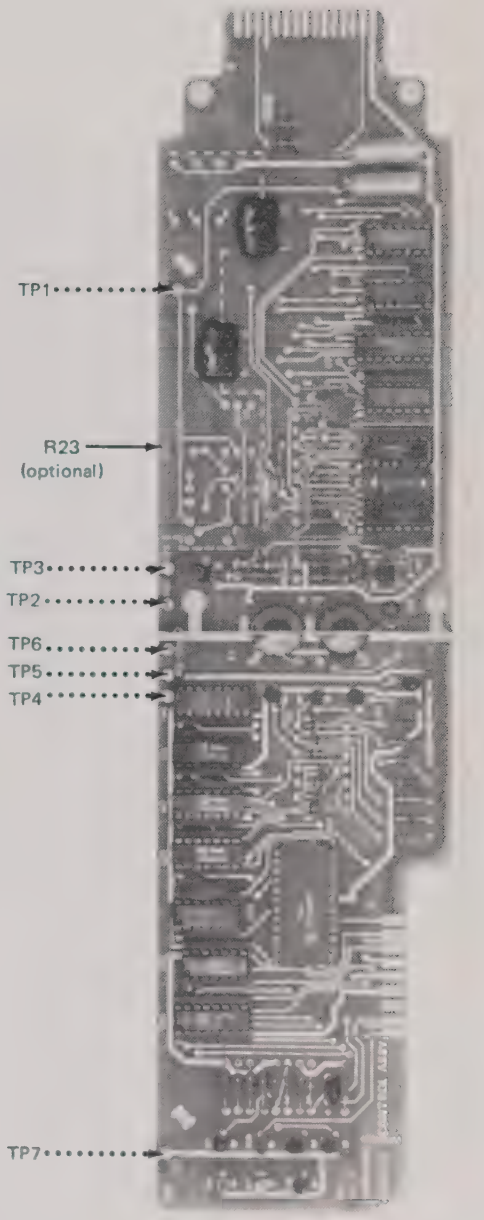
FAULT ANALYSIS

If proper indications are not obtained in steps 10 and 11, check U4A, B, C and D and associated circuitry.

12. Verify presence of REMOTE FLAG at Pin 29: Should be "True" (+5V) when REMOTE button is pressed.

FAULT ANALYSIS

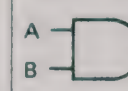
If remote flag is not present, check DS1, Q16, Q17 and associated circuitry.



TEST EQUIPMENT REQUIRED

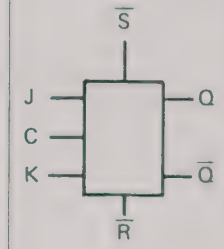
Equipment Nomenclature	Recommended Equipment
DC Power Supply	* +5V at minimum 105mA

*+5V operating power may be obtained from Data Output or Printer Output units if installed: A10P18-29 and A10P18-24 on DOU II or A16P18-15 and A16P18-16 on POU.

SYMBOL	A	B	C
	0	0	1
	0	1	1
	1	0	1
	1	1	0

LOGIC LEVELS: "1" = High (+5V)
"0" = Low (0V)

Table 1. NAND GATE TRUTH TABLE

SYMBOL	SYNCHRONOUS INPUTS		
	J	K	Q_{nt1}
	0	0	Q_n
	0	1	0
	1	0	1
	1	1	$\overline{Q}_n$

ASYNCHRONOUS INPUTS			
$\overline{S}$	R	Q	$\overline{Q}$
0	0	Undefined	
0	1	1	0 (set)
1	0	0	1 (reset)
1	1	Normal condition	

Table 2. J-K FLIP FLOP TRUTH TABLE

CALLED FUNCTION	RANGE	PIN(S)	8200A RESPONSE
None	1000	7	1000 RANGE, VDC
None	100	5	100 RANGE, VDC
None	10	1	10 RANGE, VDC
None	1	3	1 RANGE, VDC
MVDC, FILTER	10	17,26, 1	10 RANGE, MVDC, FILTER
Ω	100	11, 5	100 RANGE, Ω
KΩ	1	13, 3	1 RANGE, KΩ
MΩ	10	15	10 RANGE, MΩ
VAC	1	9, 3	1 RANGE, VAC
EXT REF	None	21	EXT REF

Table 3. RCU FUNCTIONAL CHECK

A8
Remote Control Assembly Troubleshooting Procedure
Drawing No. 8200A-1808

NOTES:

1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. DENOTES INTERNAL ADJUSTMENT.
3. DENOTES SIGNAL COMMON.
4. DENOTES A/D COMMON (CONNECTED TO SIGNAL COMMON AT TP11).
5. DENOTES FACTORY SELECTED COMPONENT (NOMINAL VALUE SHOWN).
6. DENOTES PRIMARY SIGNAL PATH.

CHANGES

(1) R79 ADDED ON S/N 340 AND ON.

(2) A0D C14 AT SERIAL NO. 620 AND ON.

A7
A/D ANALOG ASSEMBLY
DRAWING NO 8200A-1007 REV a

MODEL 8200A
TROUBLESHOOTING PROCEDURE

1. Measure voltage from A10TP1 to A10TP2 (ground). Voltage should be +5.25 VDC ±10%.

FAULT ANALYSIS

If voltage is not correct, check +5V power supply.

2. Disable autotrigger by connecting A10P18-20 to ground (A10P18-30).
3. Connect external trigger from square wave generator to A10P18-19 and A10P18-30 (ground). See Section 2, paragraph 2-46 for trigger requirements.
4. Press VDC, 1 RANGE and FILTER buttons.
5. Adjust external trigger amplitude and rate for proper triggering. Rate must be less than 400 pulses per second.
6. Apply voltages listed in Table 1, in turn, to INPUT terminals. Verify agreement between 8200A readout and decade outputs (connector A9P14). See Table 2 for DOU data output pin assignments. Use scope to check outputs with scope common connected to A10P18-30.

FAULT ANALYSIS

If proper decade outputs are not obtained, begin at the faulty outputs and work backward toward DOU input.

7. Set function and range and apply inputs to 8200A as given in Table 3. Verify agreement between 8200A readout (Table 3) and DOU data outputs.

FAULT ANALYSIS

If proper output data is not obtained, check corresponding circuits, working backward from faulty outputs.

8. Set VDC, 1 RANGE and FILTER and apply 1.11111Vdc. Verify proper output data (see Table 2).
9. Remove external input.
10. Remove short from INPUT terminals. The output data noted in step 6 should return.
11. Command a new reading by shorting A10P18-19 to ground. Data output should indicate VDC, 1 RANGE and FILTER and their output should be 1.0000.

FAULT ANALYSIS

If proper output data is not obtained, check external trigger circuitry.

12. Enable timeouts by grounding A10P18-13.
13. Connect scope to Ready Flag (output A10P18-17 with common connected to A10P18-30).
14. Command external trigger (or connect scope) (A10P18-19) and short INPUT terminals.
15. Verify Ready Flag goes momentarily false between ready flags for functions and ranges listed in Table 4.

Note

Allow external trigger rate to exceed 400 pulses per second.

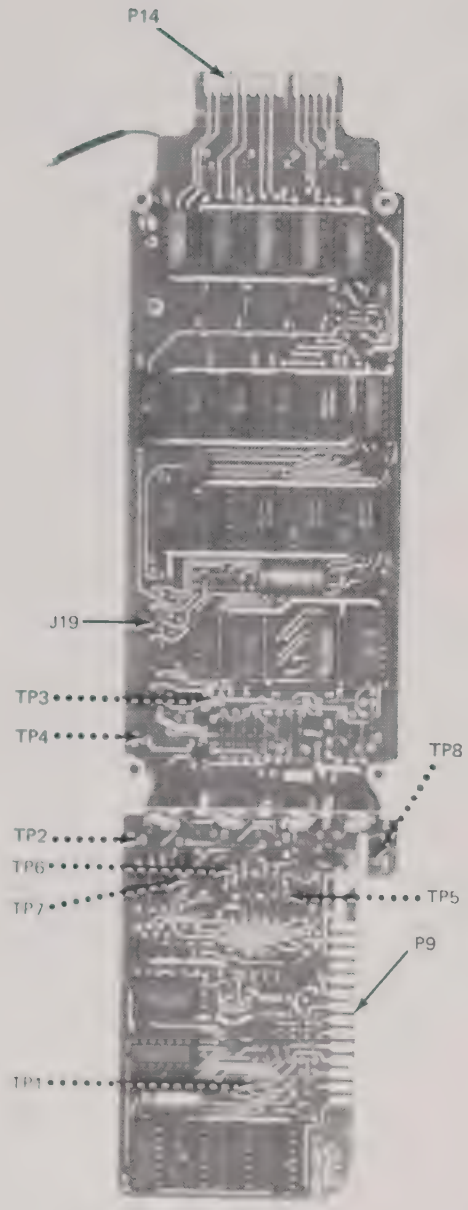
FAULT ANALYSIS

If proper pulse durations are not observed, check POS and trigger circuitry.

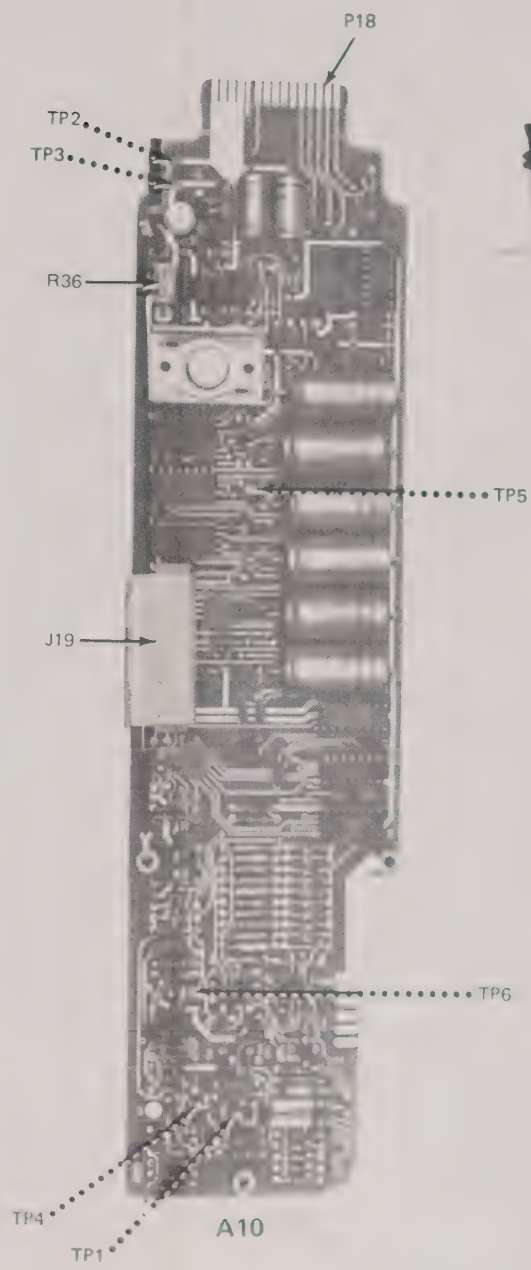
16. Set scope sweep speed to .2 sec/div.
17. Remove short from INPUT and apply 1.11111Vdc. Press VDC, 1000 RANGE and FILTER.
18. Disable timeouts by removing ground from A10P18-13. Trigger 8200A once by shorting A10P18-19 to ground. Readout should be +001.1.
19. Press AUTO range button and manually retrigger 8200A once. The time required to autorange from 1000 RANGE to 10 RANGE should be approximately 0.5 seconds.
20. Set sweep speed to .1 sec/div and repeat steps 16 through 19 with FILTER called. Autorange time should be approximately 0.2 seconds.

FAULT ANALYSIS

If proper results are not obtained in steps 16 through 20, check POS circuitry to be sure timeouts are defeated and check input trigger circuitry.



A9



A10

8200A Input Voltage (Volts)	8200A Readout
0.00000	.0000
0.11111	.1111
0.22222	.2222
0.33333	.3333
0.44444	.4444
0.55555	.5555
0.66666	.6666
0.77777	.7777
0.88888	.8888
0.99999	.9999

Table 1. DOU DIGITS CHECK

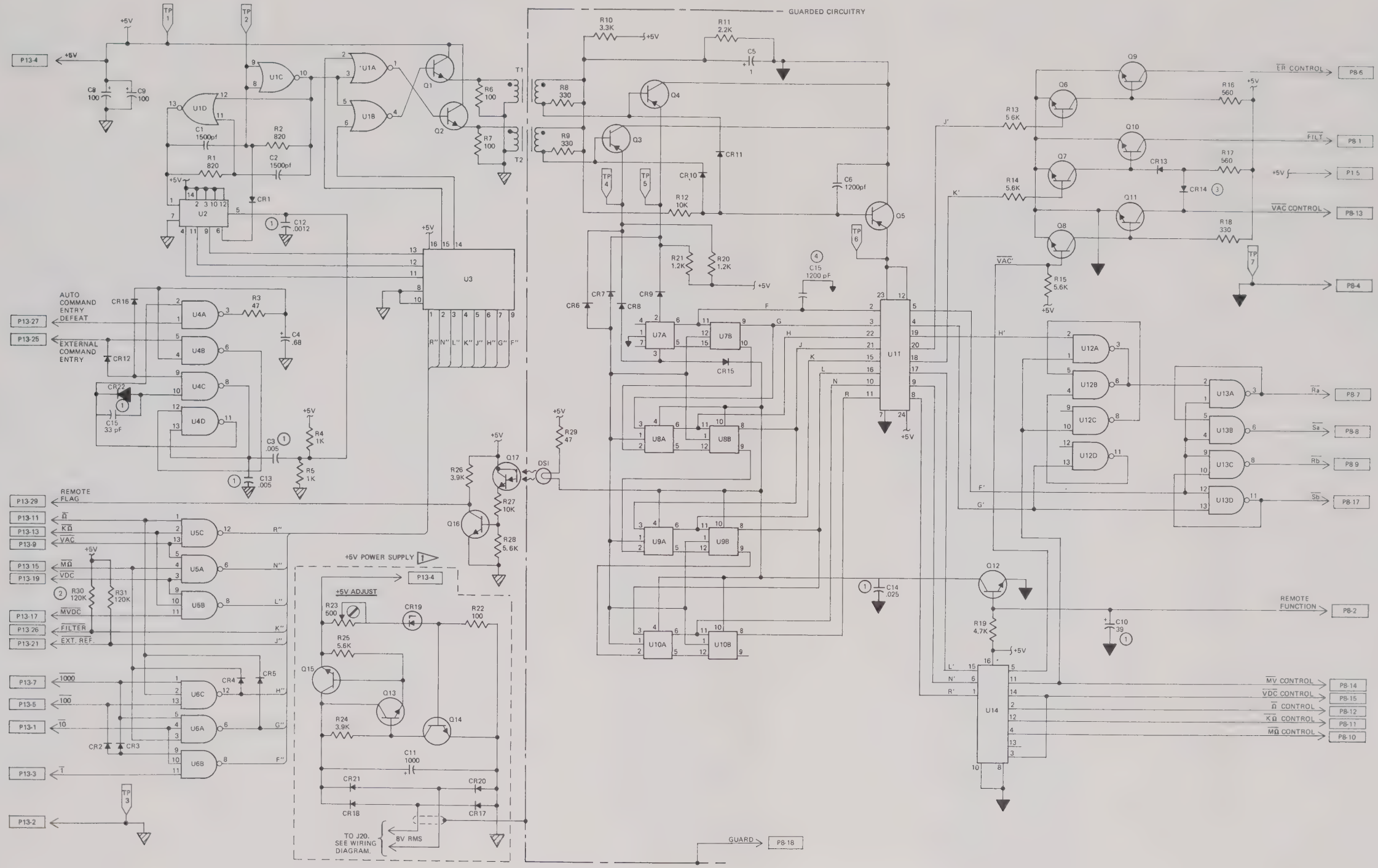
TEST EQUIPMENT REQUIRED

Equipment Nomenclature	Recommended Equipment
Oscilloscope	Tektronix 504
Voltage Calibrator	FLUKE Model 343A
Voltmeter	FLUKE Model 8100A
Trigger Generator	Tektronix Type 106 Square Wave Generator

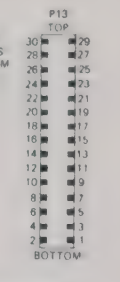
DATA	DATA OUT NO. 1	DATA OUT NO. 2	REMARKS	DATA	DATA OUT NO. 1	DATA OUT NO. 2	REMARKS
	PINS				PINS		
Function, Range and Polarity			Apply Logic "0" to gates to inhibit outputs.	1st Decade (MSD)			Logic "0" = 0V Logic "1" = +5V
VDC		6		1a		10	
MVDC		8		1b		9	
VAC		9		1c		7	
FILTER		11	Function outputs Logic "1" when true.	1d		8	Apply Logic "0" to gates to inhibit outputs.
Gate 2		2		Gate 5		4	
Ω		1		2nd Decade			
KΩ		5		2a		18	Bit Weight (a = 8
MΩ		7		2b		17	b = 4
Overload		3		2c		15	c = 2
Gate 1		4		2d		16	d = 1
				Gate 6		13	
Polarity	1			3rd Decade			
Range b	3			3a		24	
Range a	5			3b		23	
EXT REF	6			3c		21	
Gate 3	2			3d		22	
				Gate 7		19	
Overrange "1"		10		4th Decade			
Gate 4		15	— —	4a		30	
				4b		29	
Ready Flag		17	— —	4c		27	
				4d		28	
Control Inputs Timeouts Enabled		13	Enabled if connected to ground.	Gate 8		25	
				+5Vdc		29	+5V power for operation of RCU with 500 milliampere reserve.
Ext. Trigger		19		Common (for both DOU 1 and 10		24	
						26	
Autotriggering		20	Autotriggering disabled if connected to ground.			28	

Table 2. DATA OUTPUT PIN ASSIGNMENTS

A9/A10
Data Output Troubleshooting Procedure
Drawing No. 8200A-1809 and 8200A-1810 page 1 of 2



P13 PIN CONNECTIONS AS VIEWED FROM REAR OF INSTRUMENT



IC	PIN CONNECTIONS	
	+5V	COMMON
U1, U4, U6, U8, 10, U12, U13	14	7
U3, U7	16	8

NOTES

1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ⊘ DENOTES INTERNAL ADJUSTMENT.
3. ▼ DENOTES LOGIC COMMON.
4. ▽ DENOTES EXTERNAL GROUND OR COMMON
5. (1) THIS POWER SUPPLY INSTALLED ONLY IN SPECIAL RCU, 8200A-08/AA. PROVIDES +5V LOGIC POWER TO RCU EXTERNAL GUARD CIRCUITRY IN LIEU OF DOU OR POU LOGIC SUPPLIES WHEN THESE OPTIONS ARE NOT INSTALLED. CONTACT FACTORY FOR DETAILS.

CHANGES

(1) ADDED C12, C13, C14, CR22 AND CHANGED C3 AND C10 IN SER NO 193 AND ON
(2) ADDED R30, R31 IN SER NO 148 AND ON
(3) CR 14 DELETED DUE TO DC COUPLING REQUIREMENT OF -09 OPTION
(4) ADDED C-15 ON SER NO 86408 AND ON

A8
REMOTE CONTROL ASSEMBLY
DRAWING NO. 8200A-1009 REV a

(continued from page 1 of 2)

Input Voltage	Range Called	Functions Called	8200A Readout		
			Readout	Display	Overload
−1.0000	1	VDC, Filter	−1.0000±1	VDC, Filter	No
+2.0000	1	VDC, Filter	+1.5999	VDC, Filter	Yes
+2.0000	10	MΩ	15.999	MΩ	Yes
+2.0000	100	Ω	159.99	Ω	Yes
+2.0000	100	MVDC	+159.99	MVDC	Yes
+2.0000	1000	VAC, Ext. Ref.	000.0	VAC, Ext. Ref.	Yes
+2.0000	1000	KΩ	1599.9	KΩ	Yes

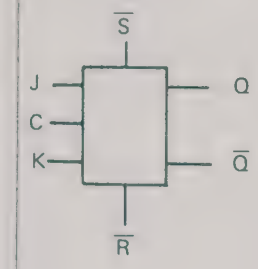
Table 3. FUNCTION/RANGE CHECK

Function Called	Range Called	POS Pulse Duration	Scope Setting
VDC	100	15 ±2ms	5ms/Div
Ω	100	16 ±2ms	5ms/Div
KΩ	100	17 ±2ms	5ms/Div
MΩ	10	44 ±5ms	5ms/Div
MVDC	10	120 ±15ms	20ms/Div
VDC, Filter	10	530 ±60ms	.1 sec/Div
VAC, Filter	10	850 ±90ms	.1 sec/Div
Ω, Filter	100	560 ±60ms	.1 sec/Div
KΩ, Filter	100	1.3 ±0.15 sec	.2 sec/Div
MVDC, Filter	100	2.1 ±0.25 sec	.5 sec/Div
MΩ, Filter	10	7.4 ±0.8 sec	1 sec/Div

Table 4. POS PULSE TIMES

SYMBOL	A	B	C
	0	0	1
	0	1	1
	1	0	1
	1	1	0
	0	0	1
	0	1	0
	1	0	0
	1	1	0
LOGIC LEVEL "1" = High (+5V) "0" = Low (0V)			

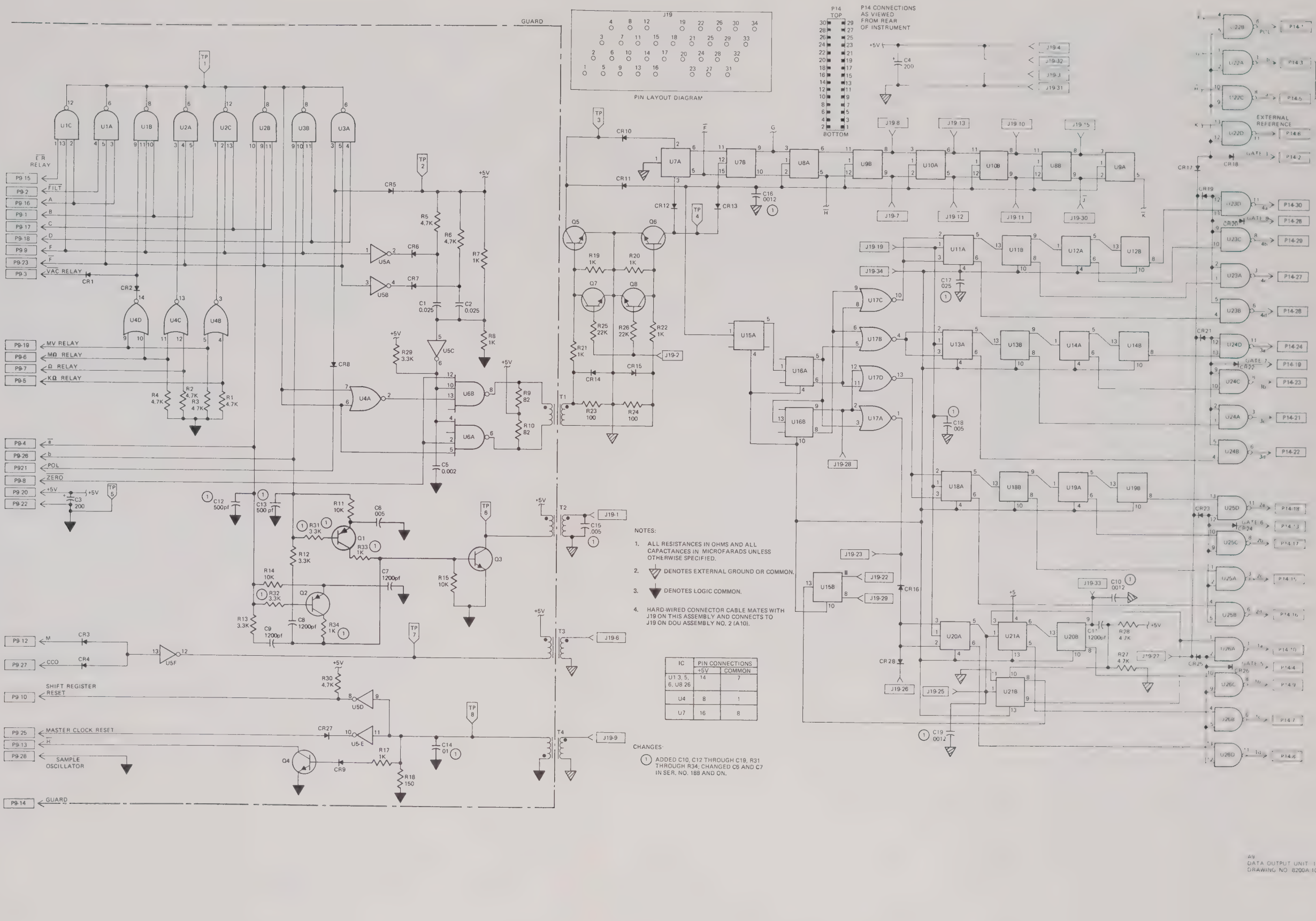
Table 5. NAND NOR GATE TRUTH TABLE

SYMBOL	SYNCHRONOUS INPUTS		
	J	K	Q_{nt1}
	0	0	Q_n
	0	1	0
	1	0	1
	1	1	$\overline{Q}_n$

ASYNCHRONOUS INPUTS			
$\overline{S}$	$\overline{R}$	Q	$\overline{Q}$
0	0	Undefined	
0	1	1	0 (set)
1	0	0	1 (reset)
1	1	Normal condition	

Table 6. J-K FLIP FLOP TRUTH TABLES

A9/A10
Data Output Troubleshooting Procedure
Drawing No. 8200A-1809 and 8200A-1810 page 2 of 2



NOTES:

1. ALL RESISTANCES IN OHMS AND ALL CAPACTANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ▽ DENOTES EXTERNAL GROUND OR COMMON.
3. ▼ DENOTES LOGIC COMMON.
4. HARD-WIRED CONNECTOR CABLE MATES WITH J19 ON THIS ASSEMBLY AND CONNECTS TO J19 ON DOU ASSEMBLY NO. 2 (A10).

IC	PIN CONNECTIONS	
	+5V	COMMON
U1, 3, 5, 6, U8, 26	14	7
U4	8	1
U7	16	8

CHANGES:

(1) ADDED C10, C12 THROUGH C19, R31 THROUGH R34; CHANGED C5 AND C7 IN SER. NO. 188 AND ON.

A9
DATA OUTPUT UNIT 1
DRAWING NO. 8200A-1009 REV 4

MODEL 8200A
TROUBLESHOOTING PROCEDURE

1. Make equipment connections shown in Figure 1.

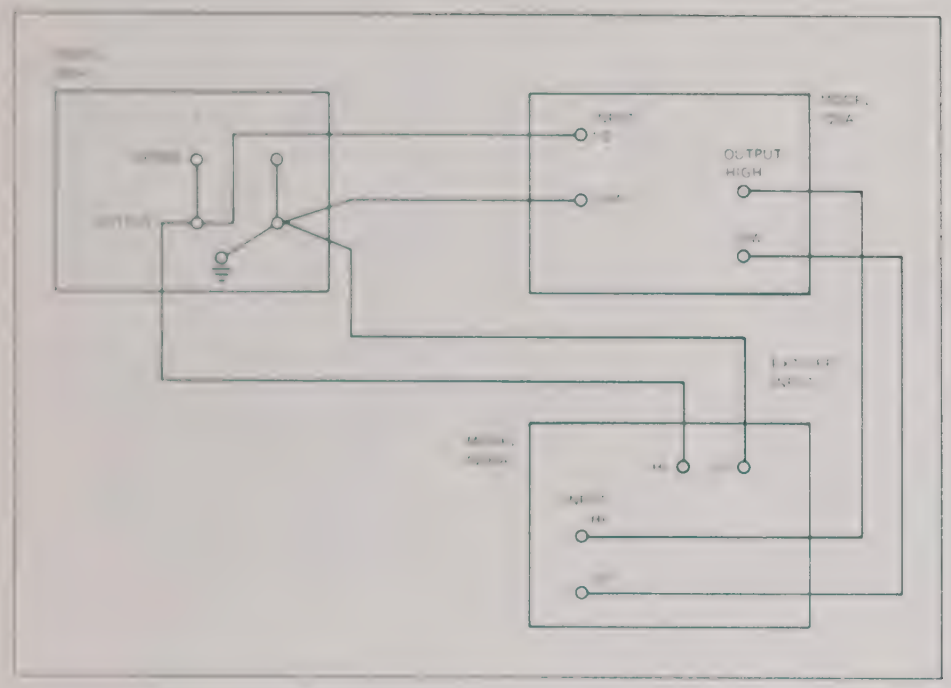


Figure 1. EQUIPMENT CONNECTIONS FOR EXTERNAL REFERENCE CALIBRATION AND LINEARITY CHECK

2. Press VDC, FILTER, EXT REF and RANGE 1 buttons.
3. Short test points A6TP2 and A6TP3 together (Logic Assembly PCB).
4. Set 725A divider dials to .1000550.
5. Set 343A output to +10 volts dc. Model 8200A readout should be +1.000X where "X" flickers uniformly between "5" and "6".
6. Reduce 343A output to +3 volts dc. Model 8200A readout should be 1.000X where "X" flickers uniformly between "5" and "6".

FAULT ANALYSIS

If proper results are not obtained in steps 5 and 6, check R12 (3V) and R2 (10V) adjustments, respectively.

7. Set 720A divider dials to .1000500
8. Set 343A output as shown in Table 1. Model 8200A readout error should not exceed tolerance given in the table

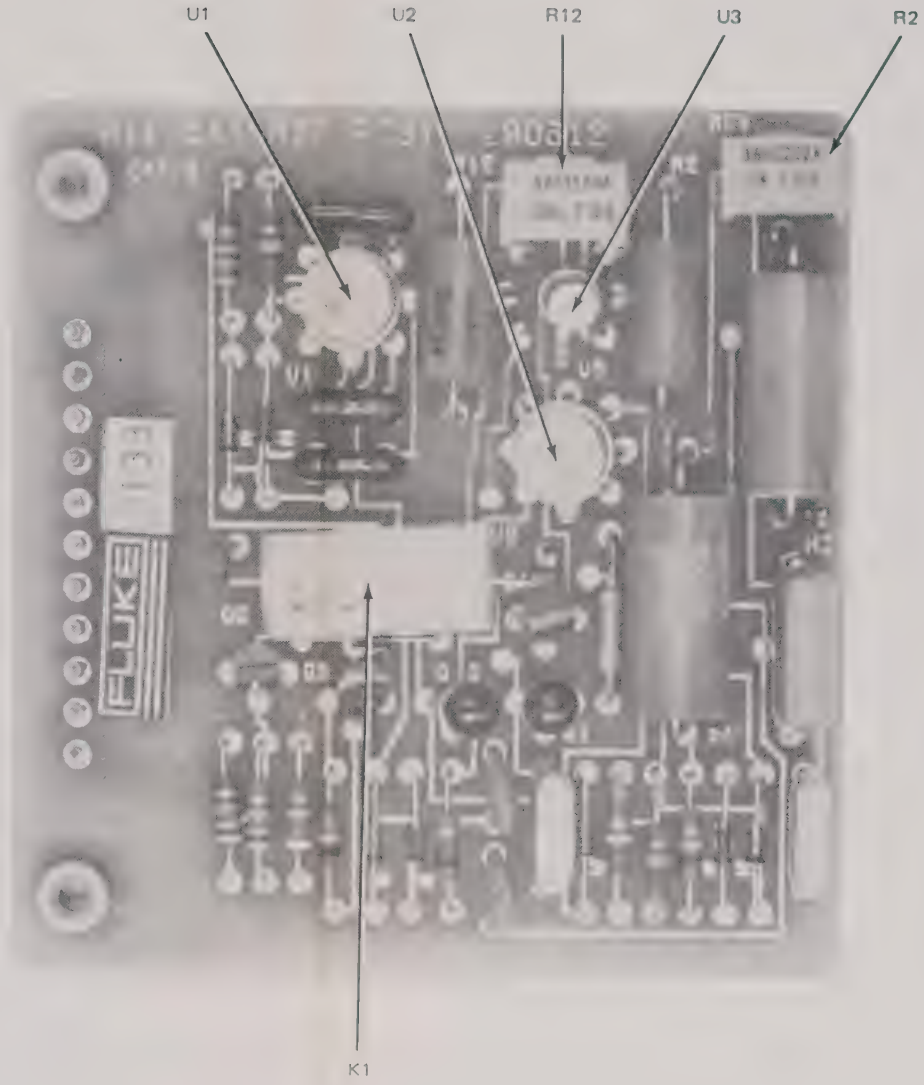
FAULT ANALYSIS

If error in step 8 is excessive, check calibration of External Reference assembly and check U1, U2 and U3.

9. Set 343A output to +10 volts.
10. Set 720A dials to .6000000
11. Set 8200A to 10 RANGE and note Model 8200A readout.
12. Reverse input to Model 8200A INPUT only. Readout should be within 1 digit of that noted in step 10

FAULT ANALYSIS

If proper results are not obtained, check calibration of External Reference assembly.



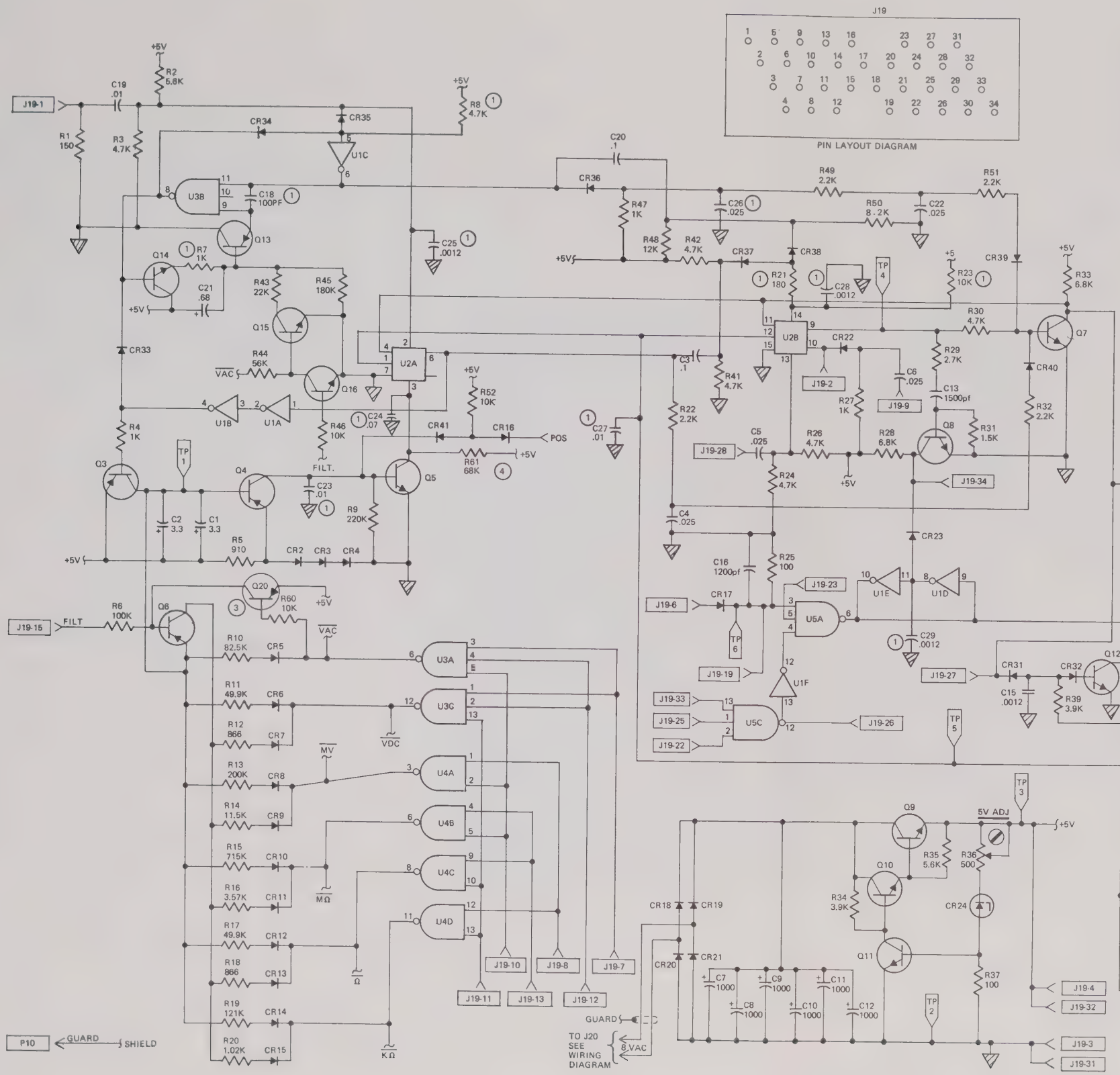
TEST EQUIPMENT REQUIRED

Equipment Nomenclature	Recommended Equipment
Voltage Calibrator	FLUKE Model 343A
Voltage Divider	FLUKE Model 720A

Model 343A Output Volts (Ext Ref Input)	Model 8200A	
	Readout	Tolerance (digits)
2	+1.0005	±5
4		±3
5		±2
6		±2
7		±1
8		±1
9		±1
11		±1

Table 1. LINEARITY CHECK

A11
External Reference Assembly Troubleshooting Procedure
Drawing No. 8200A-1811


J19
PIN LAYOUT DIAGRAM
P18
TOP
BOTTOM
P18 PIN CONNECTIONS AS VIEWED FROM REAR OF INSTRUMENT.
IC | PIN CONNECTIONS | +5V | COMMON
U1-U8 | 14 | 7
U2 | 16 | 8
NOTES:
1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. DENOTES INTERNAL ADJUSTMENT.
3. DENOTES EXTERNAL GROUND OR COMMON.
4. HARD-WIRED CONNECTOR CABLE MATES WITH J19 ON THIS ASSEMBLY AND CONNECTS TO J19 ON DOU ASSEMBLY NO. 1. (A9).
CHANGES:
(1) ADDED C23 THROUGH C29, R7, R8, R21, R23 AND CR42 IN SER. NO. 188 AND ON.
(2) DELETED CR42 AT SERIAL NO. 180 AND ON.
(3) ADDED Q20 NAD R60 SN 11200 AND ON.
(4) ADDED R61 SN 1060 AND ON.
P18-29
P18-30
P18-28
P18-26
P18-24
P18-6
P18-8
P18-9
P18-11
P18-2
P18-1
P18-7
P18-5
P18-3
P18-4
P18-17
P18-10
P18-15
P18-13 TIMEOUTS ENABLED
P18-19 EXTERNAL TRIGGER (DYNAMIC "1" TRIGGER)
P18-20 AUTO TRIGGERING DISABLED IF CONNECTED TO GROUND
P10 GUARD SHIELD
TO J20 SEE WIRING DIAGRAM
A10
DATA OUTPUT UNIT-II
DRAWING NO 8200A 1010 REV. a

MODEL 8200A
TROUBLESHOOTING PROCEDURE

1. Press VDC, FILTER and 10 RANGE buttons.
2. Apply +16 volts to the INPUT terminals. Readout should be +15.999.
3. Apply 9.999 volts to INPUT and check the individual digits in each readout tube by decreasing the INPUT voltage in steps of one digit per decade to −0.001 volts. Final readout should be −0.001.

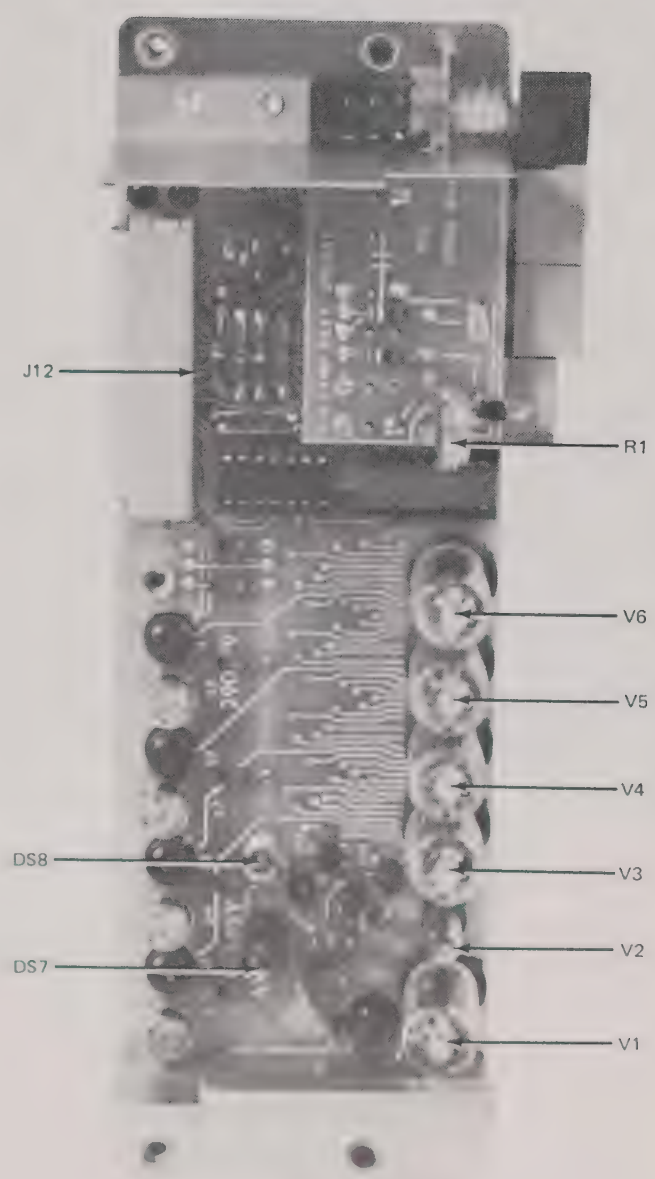
FAULT ANALYSIS

If proper results are not obtained, locate system in Table 1 and make corresponding checks.

4. Disconnect shorting strap from between INPUT LO and GUARD terminals and apply +100 volts between INPUT LO (positive) and GUARD (negative). The neon warning lamp (located behind front panel display) should not be lit.
5. Increase input voltage until the neon warning lamp lights. Voltage input should be less than +150 volts dc.

FAULT ANALYSIS

If proper indications are not obtained, check DS7 and DS8.



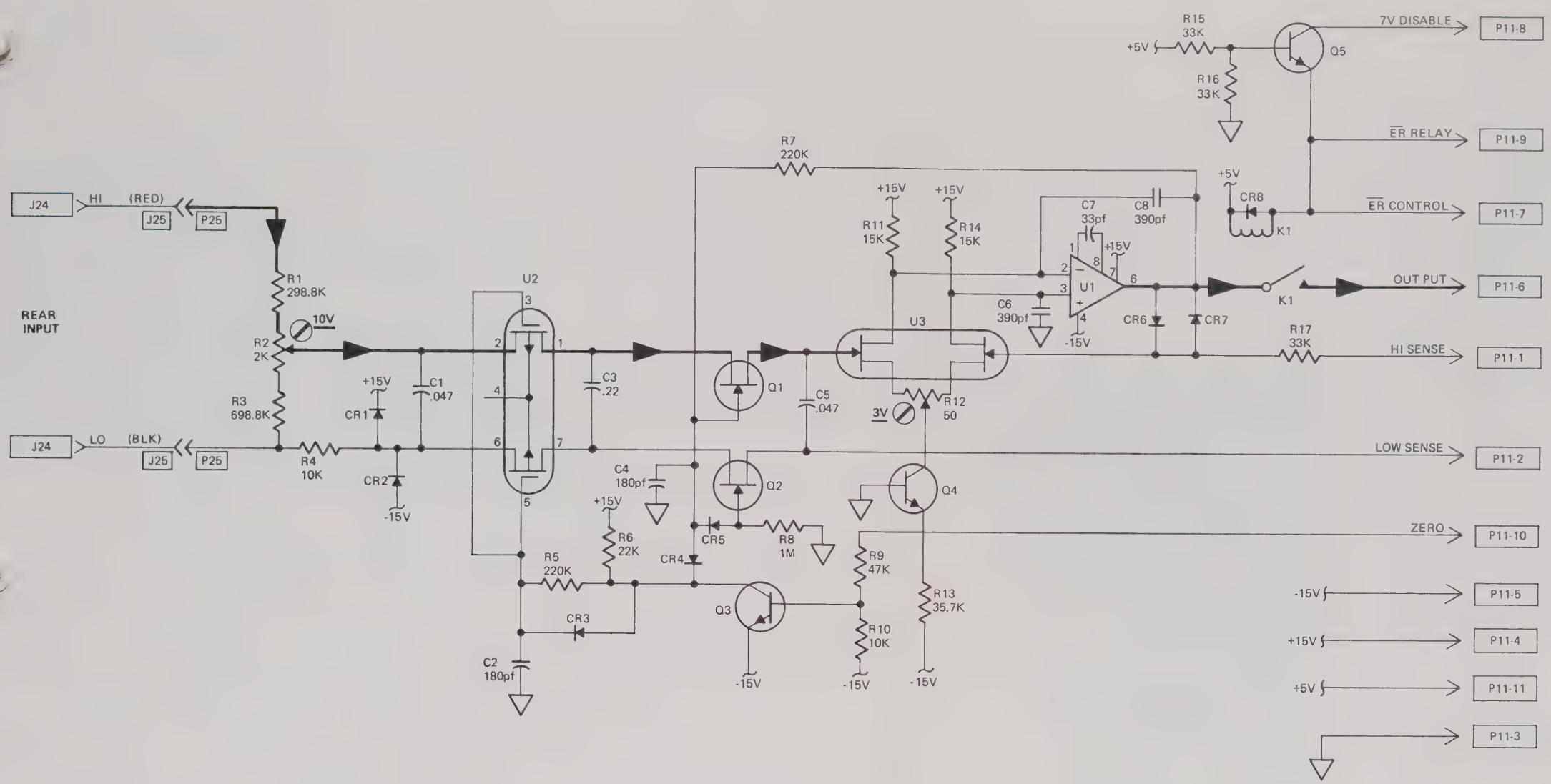
TEST EQUIPMENT REQUIRED

Equipment Nomenclature	Recommended Equipment
DC Voltage Calibrator	FLUKE Model 3

SYMPTOM	ACTION TO BE TAKEN
Incorrect or no polarity indication	Check V1, Q13 through Q16, Q18 and associated circuitry.
Incorrect overrange indication	Check V2, Q9 and U2A
One or more digits in a readout tube do not illuminate	Replace defective readout tube. V3 displays the most significant digit, V4 the next most, V5 the next most and V6 the least significant digit.
One or more but not all readout tubes are completely dark	Check appropriate anode switch circuits, Q1 through Q8, and corresponding drive signals.
All readout tubes are dark	Check +200V at A12U12-6. Check U1, U2 and associated BCD input signals.

Table 1. DISPLAY TROUBLESHOOTING

A12
Display Assembly Troubleshooting Procedure
Drawing No. 8200A-1812



NOTES:

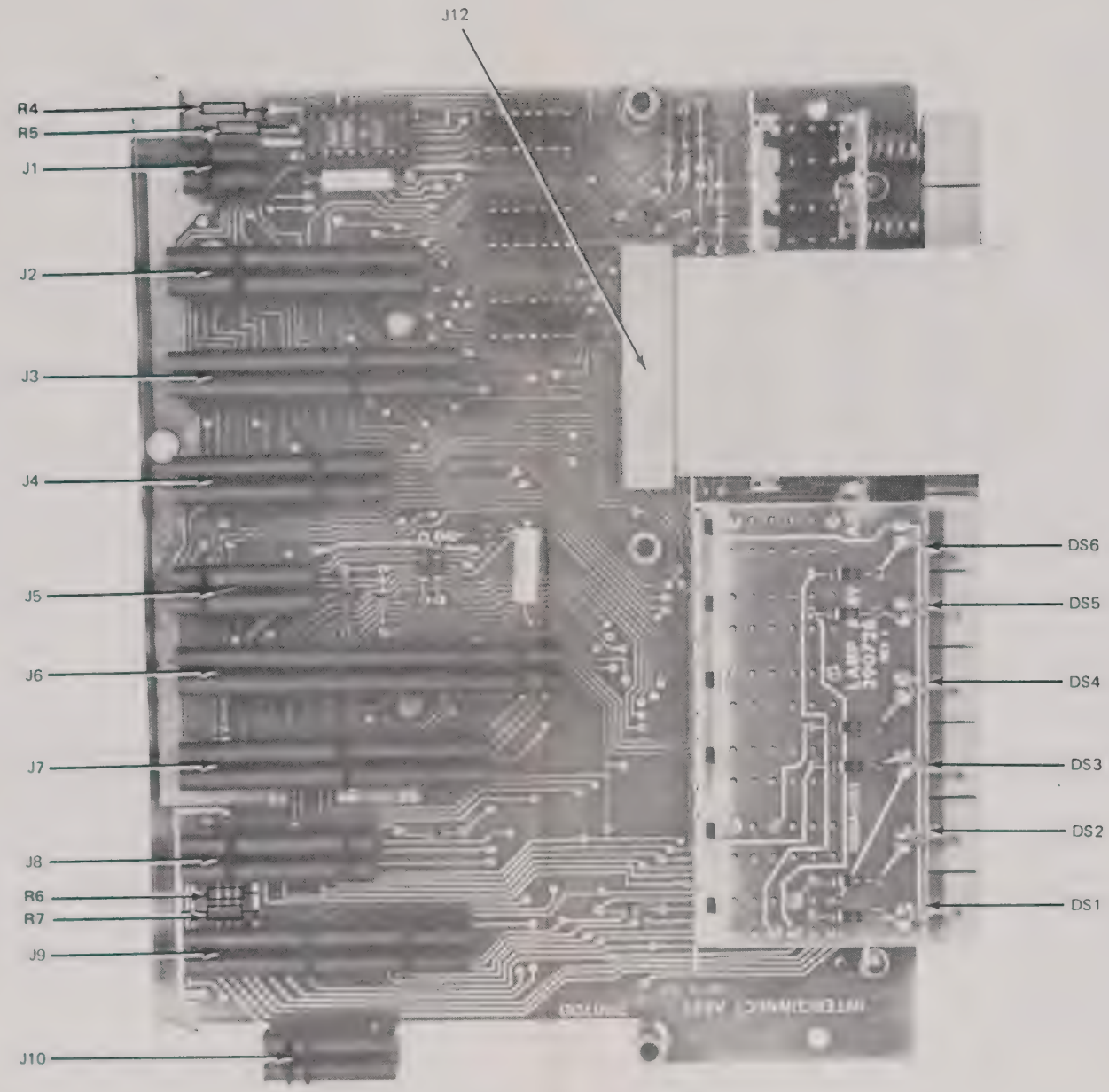
1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ⊘ DENOTES INTERNAL ADJUSTMENT.
3. ▽ DENOTES SIGNAL COMMON.
4. ▬▶ DENOTES PRIMARY SIGNAL PATH.

A11
EXTERNAL REFERENCE ASSEMBLY
DRAWING NO. 8200A-1011

MODEL 8200A
TROUBLESHOOTING PROCEDURE

1. Remove Buffer (A4) and Millivolts Converter (A3) subassemblies to gain access to connectors A13J3 and A13J4.
2. Set the Model 8200A RANGE as shown in Table 1 and check for proper operation of range logic by measuring the logic levels at the following points per Table 1.

Test Point	Range Line	Logic Common
A13J4-6	$\overline{a}$	A13J4-14
A13J3-9	a	A13J3-10
A13J4-5	$\overline{b}$	A13J4-14
A13J3-11	b	A13J3-10



RANGE CODE

RANGE	$\overline{a}$	$\overline{b}$	a	b
1	1	1	0	0
10	1	0	0	1
100	0	1	1	0
1000	0	0	1	1
LOGIC "1" = High (+5V) LOGIC "0" = Low (0V)				

Table 1. RANGE LOGIC TRUTH TABLE

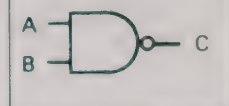
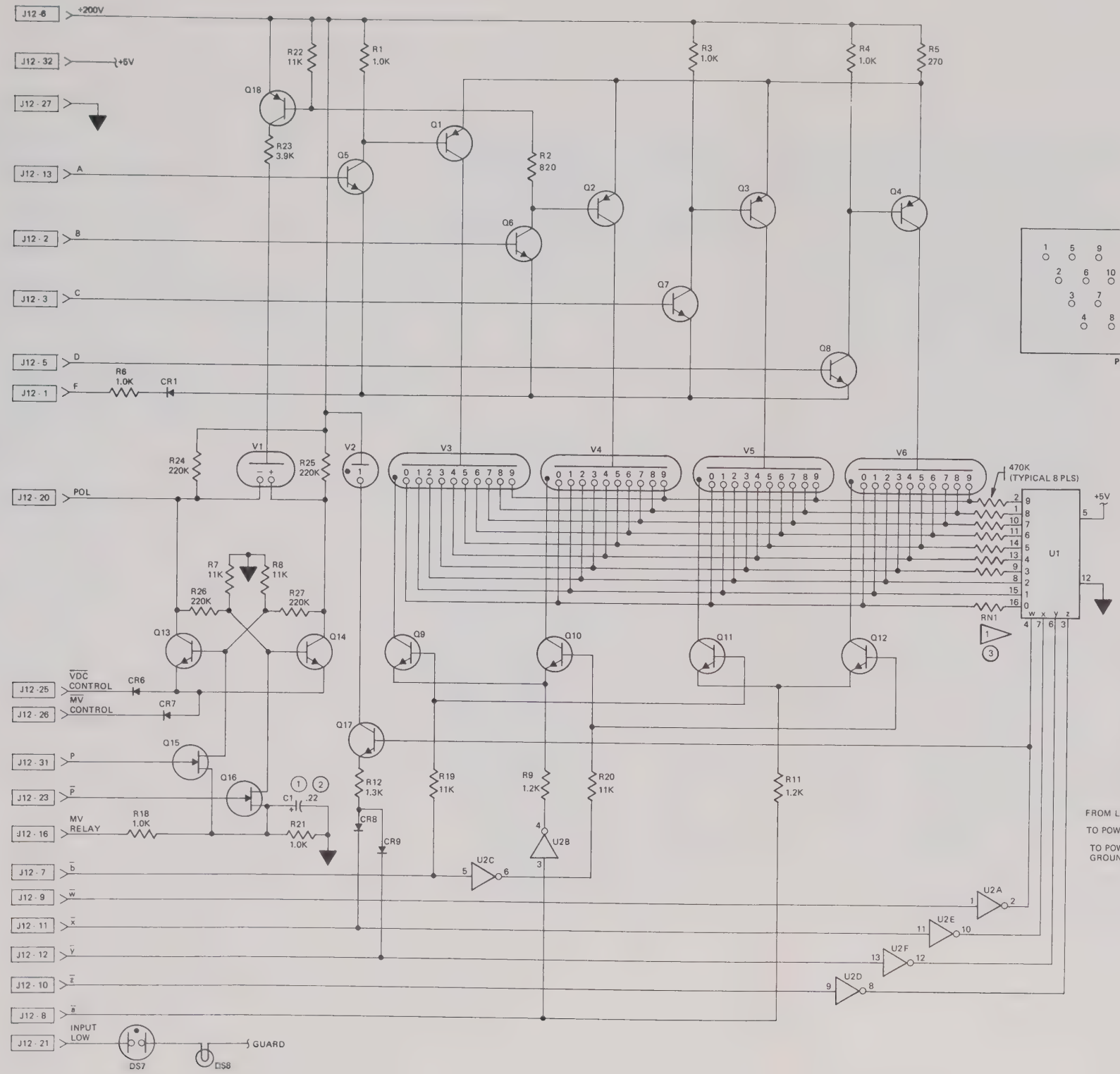
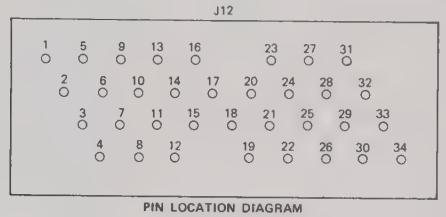
SYMBOL	A	B	C
	0	0	1
	0	1	1
	1	0	1
	1	1	0
LOGIC LEVELS: "1" = High (+5V) "0" = Low (0V)			

Table 2. NAND GATE TRUTH TABLE

A13
Interconnect Assembly Troubleshooting Procedure
Drawing No. 8200A-1813



IC	PIN CONNECTIONS	
	+5V	COMMON
U2	14	7



PIN LOCATION DIAGRAM

NOTES:

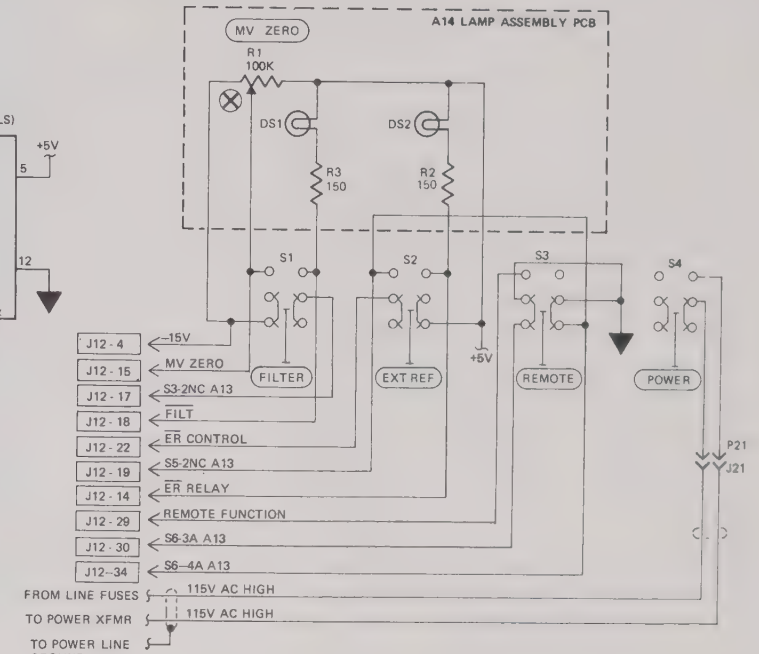
1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ▼ DENOTES LOGIC COMMON.
3. ⬭ DENOTES FRONT PANEL LOCATION.
4. HARD WIRED CONNECTOR CABLE MATES WITH J12 ON THIS ASSEMBLY AND CONNECTS TO J12 ON INTERCONNECT ASSEMBLY A13.
5. ⊗ DENOTES FRONT PANEL ADJUSTMENT.
6. (1) ▷ RESISTOR R28 THROUGH R36 ARE MOUNTED INSIDE RN1

CHANGES:

(1) C1 CHANGED FROM 0.05 MFD TO 0.22 MFD SER. NO. 249 AND ON.

(2) C1 DELETED ON SER. NO. 448 AND ON.

(3) RESISTOR NETWORK R28 - R36 ADDED SER. NO. 650 AND ON.



A12
DISPLAY ASSEMBLY
DRAWING NO. 8200A-1012 REV a

MODEL 8200A
TROUBLESHOOTING PROCEDURE

1. Connect voltmeter between A16TP4 and A16TP3 (ground). Voltage should be +5.25 ±0.1 volts.

FAULT ANALYSIS

If voltage is not correct, check adjustment of R18 (5V ADJUST) and check +5V power supply.

2. Disconnect voltmeter and connect voltage calibrator to INPUT terminals.
3. Disable autotrigger by connecting A16P18-14 to A16P18-16 (ground).
4. Press VDC, 1 RANGE and FILTER buttons.
5. Apply voltages to INPUT, in turn, as shown in Table 1. With each input, trigger the POU by connecting the External Trigger input pin (A16P18-13) to ground (A16P18-16). Verify agreement between 8200A readout and POU decade outputs. See Table 2 for POU pin assignments and Table 3 for truth tables and logic levels.

FAULT ANALYSIS

If proper decade outputs are not obtained, begin at the faulty outputs and work backward toward POU input.

6. Repeat step 5 with inputs and functions specified in Table 4. Verify correct data output. Refer to Table 5 for Range/Function Indicator (Pin A16P18-12) coding.

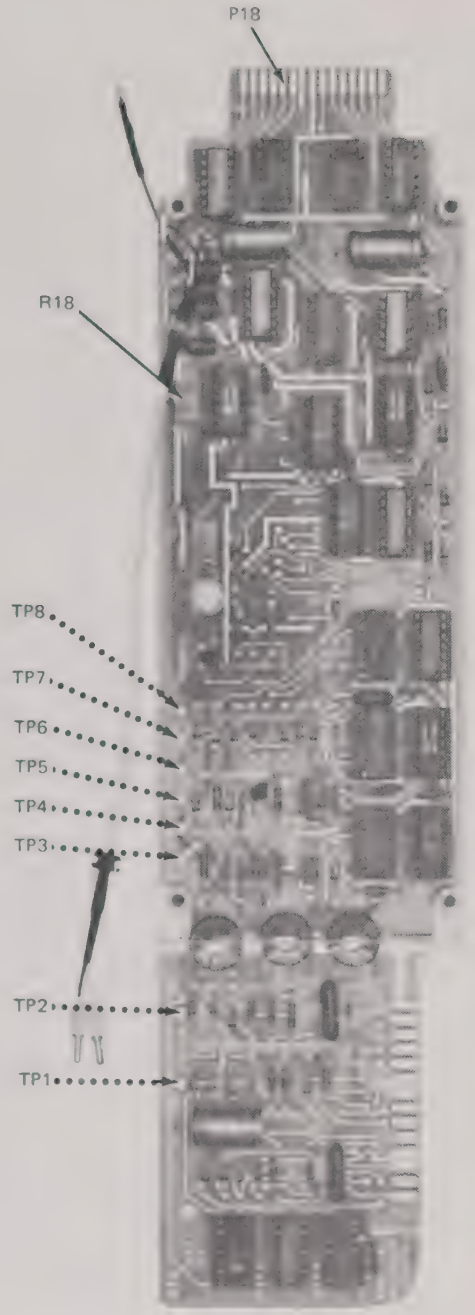
FAULT ANALYSIS

If proper output data is not observed, work backward from faulty outputs to isolate problem.

7. Disconnect voltage calibrator from INPUT terminals and press VDC, FILTER and 100 RANGE buttons.
8. Short INPUT terminals.
9. Enable autotriggering by removing ground from Pin A16P18-14.
10. Observe Ready Flag (Pin A16P18-26) on scope with scope sweep speed at 1ms/Div. Ready Flag should be a +5 volt pulse with a duration of 2.25 ±0.2 milliseconds. Pulse rate should be approximately 4 pulses per second.

FAULT ANALYSIS

If proper results are not obtained in step 10, check trigger circuitry, check U4B and Q1 and associated circuitry and check for proper multiplexer inputs.



OUTPUT	PIN	TRUTH TABLE
FUNCTION	12	1 = VDC OR VAC OR KILOHMS (KΩ) (SEE TABLE 5)* 0 = MVDC OR OHMS (Ω) OR MEGOHMS (MΩ)
RANGE a b	10 11	a b: 0 0 = 1 RANGE; 0 1 = 10 RANGE; 1 0 = 100 RANGE; 1 1 = 1000 RANGE
POLARITY	21	1 = NEGATIVE 0 = POSITIVE
OVERRANGE	20	1 = DECIMAL "1" 0 = DECIMAL "0"
FIRST DECADE (MSD) a b c d	24 23 22 21	BCD: a 8, b 4, c 2, d 1
SECOND DECADE a b c d	5 4 3 2	BCD: a 8, b 4, c 2, d 1
THIRD DECADE a b c d	27 26 32 31	BCD: a 8, b 4, c 2, d 1
FOURTH DECADE (LSD) a b c d	29 25 30 28	BCD: a 8, b 4, c 2, d 1
AUTO TRIGGER DISABLE	14	LOGIC 0 OR SHORT INHIBITS INTERNAL TRIGGER AND ENABLES 8200A TO ACCEPT EXTERNAL TRIGGER. LOGIC 1 OR OPEN ENABLES INTERNAL TRIGGER
EXTERNAL TRIGGER INPUT	13	TRANSITION FROM LOGIC 0 TO LOGIC 1 COMMANDS 8200A TO READ
READY FLAG	26	1 = NOT READY 0 = READY
POWER SUPPLY +5VDC	15 16	605 mA AVAILABLE. CRCU REQUIRES 105 mA. ISOLATED FROM INPUT LO AND CHASSIS
SPARE INVERTER	b a	
LOGIC "1" = +5V. LOGIC "0" = 0 to +0.5V		

Table 2. PRINTER OUTPUT UNIT FUNCTIONAL PIN CONNECTIONS

OUTPUTS	LINES	OUTPUT LOGIC LEVELS	
		0 to +0.5V	+5V
Function Indicator	1	Logic "0"	Logic "1"
4 Digits BCD 8-4-2-1	16		
Range (coded)	2		
Overrange Digit	1		
Polarity "+" = 0 "−" = 1	1		
Ready Flag	1	Ready	Not Ready
External Trigger or Autotriggering Inputs	1	Inhibit	Enable

RANGE	LINE a	LINE b
1000	1	1
100	1	0
10	0	1
1	0	0

Table 3. PRINTER OUTPUT UNIT TRUTH TABLES AND LOGIC LEVELS

8200A Input (Volts)	8200A Readout
0.11111	.1111
0.22222	.2222
0.33333	.3333
0.44444	.4444
0.55555	.5555
0.66666	.6666
0.77777	.7777
0.88888	.8888
0.99999	.9999

Table 1. POU DIGITS CHECK

SYMBOL	SYNCHRONOUS INPUTS J	K	Q_{ntl}
	0	0	Q_n
	0	1	0
	1	0	1
	1	1	$\overline{Q}_n$

ASYNCHRONOUS INPUTS $\overline{S}$	$\overline{R}$	Q	$\overline{Q}$
0	0	Undefined	
0	1	1	0 (set)
1	0	0	1 (reset)
1	1	Normal condition	

Table 7. J-K FLIP FLOP TRUTH TABLES

A16
Printer Output Unit Troubleshooting Procedure
Drawing No. 8200A-1816

TEST EQUIPMENT REQUIRED

Equipment Nomenclature	Recommended Equipment
Voltage Calibrator	FLUKE Model 343A
Oscilloscope	Tektronix Model 504
Voltmeter	FLUKE Model 8100A
Trigger Generator	Tektronix Type 106 Square Wave Generator

INPUT VOLTAGE	FUNCTION DEPRESSED	RANGE DEPRESSED	DISPLAY	FUNCTION INDICATOR
−2.0	VDC	1	−1.5999	On
+2.0	VDC	1	+1.5999	On
+2.0	MΩ	10	+15.999	Off
+2.0	Ω	100	+159.99	Off
+2.0	VAC	1000	+000.2+2	On
+2.0	KΩ	1000	+1599.9	On

Table 4. RANGE, FUNCTION AND POLARITY CHECKS

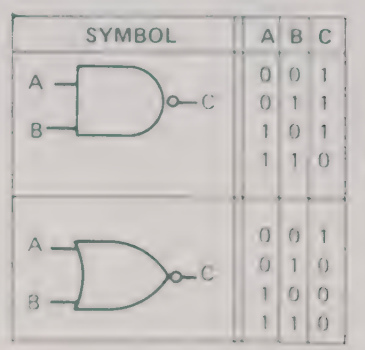
FUNCTION PROGRAMMED	RANGE a	RANGE b	FUNCTION INDICATOR	FUNCTION CALLED	RANGE CALLED
** VDC, MVDC	0	1	0	MVDC	10
VDC, MVDC	1	0	0	MVDC	100
VDC, MVDC	0	0	1	VDC	1
VDC, MVDC	0	1	1	VDC	10
VDC, MVDC	1	0	1	VDC	100
VDC, MVDC	1	1	1	VDC	1000
VAC	0	0	1	VAC	1
VAC	0	1	1	VAC	10
VAC	1	0	1	VAC	100
VAC	1	1	1	VAC	1000
** Ω *	1	0	0	Ω	100
KΩ	1	0	0	Ω	100
KΩ	0	0	1	KΩ	1
KΩ	0	1	1	KΩ	10
KΩ	1	0	1	KΩ	100
KΩ	1	1	1	KΩ	1000
KΩ	0	1	0	MΩ	10
MΩ	0	1	0	MΩ	10

* When Ω or MΩ function is programmed, the range is automatically commanded.

** MV/VDC or Ω/kΩ/MΩ autoranging ability of the 8200A can result in the final reading being taken in a function other than the one programmed.

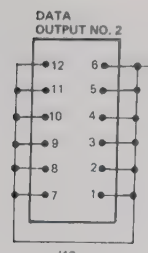
For example: Autoranging with an open input will result in a reading on the 10 range, MΩ function even though the Ω function was programmed.

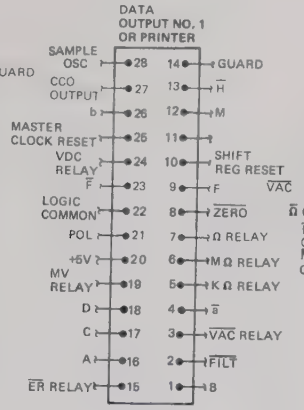
Table 5. RANGE/FUNCTION INDICATOR CODING

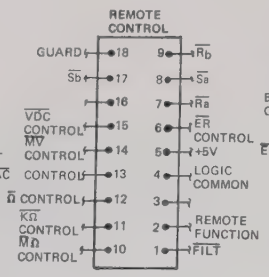


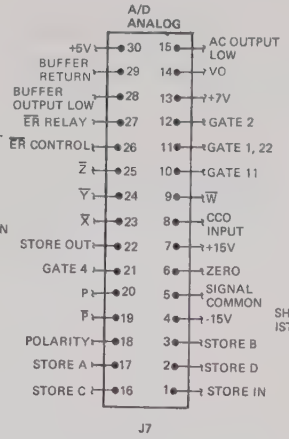
A	B	C
0	0	1
0	1	1
1	0	1
1	1	0
0	0	1
0	1	0
1	0	0
1	1	0

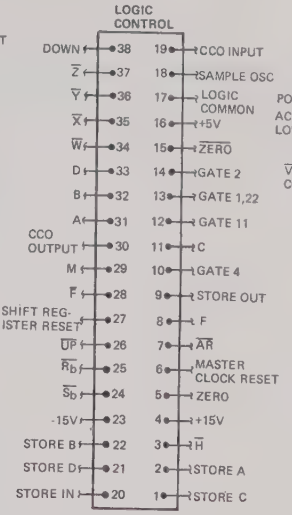
Table 6. NAND/NOR GATE TRUTH TABLE

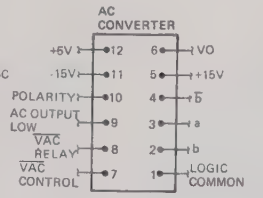


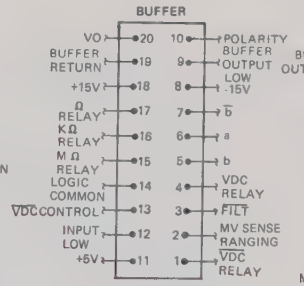


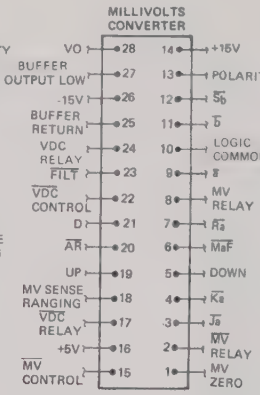


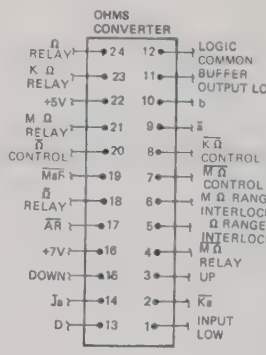


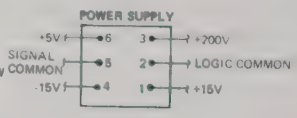


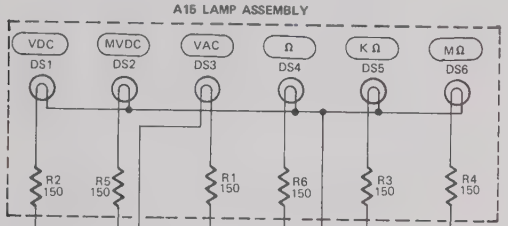


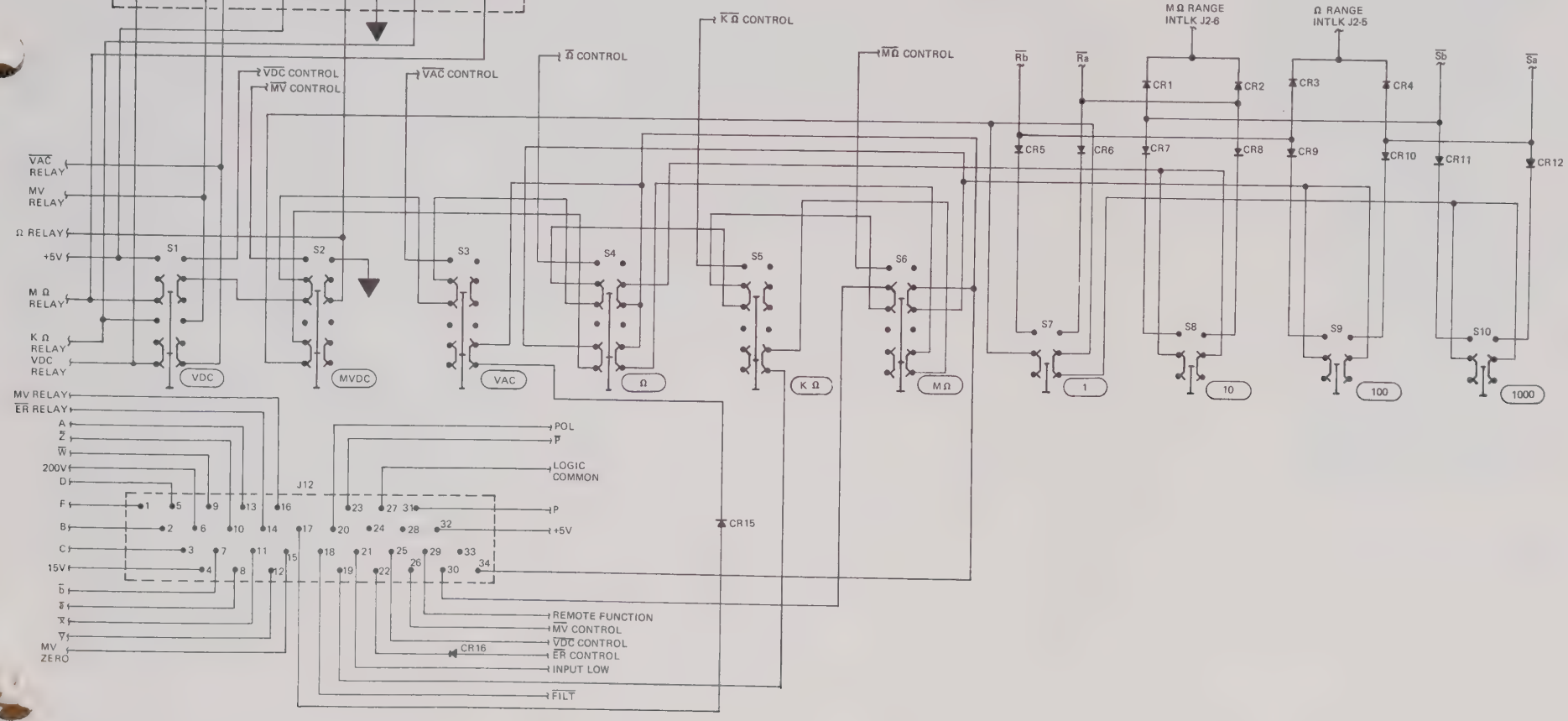


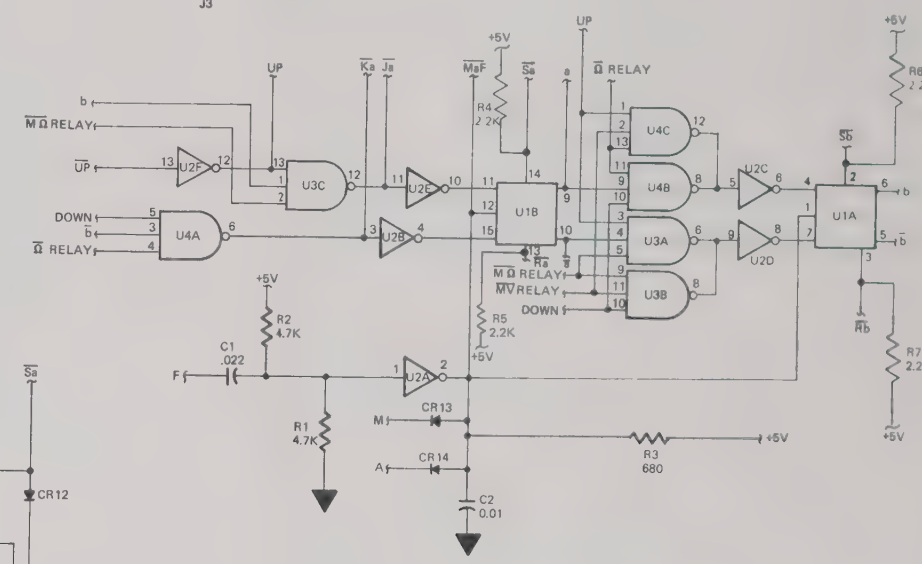












RANGE CODE				
RANGE	a	b	a	b
1	1	1	0	0
10	1	0	0	1
100	0	1	1	0
1000	0	0	1	1

NOTES:
1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARDS UNLESS OTHERWISE SPECIFIED.
2. ( ) DENOTES FRONT PANEL LOCATION.
3. ▼ DENOTES LOGIC COMMON.
4. HARD-WIRED CONNECTOR CABLE MATES WITH J12 ON THIS ASSEMBLY AND CONNECTS TO J12 ON DISPLAY ASSEMBLY A12.

A13
INTERCONNECT ASSEMBLY
DRAWING NO. 8200A 1013 REV. a

Model 8200A
Troubleshooting Procedure

1. Turn instrument on and allow to operate for at least 10 minutes. Erroneous indications may be observed if instrument does not have sufficient "warm-up" time.

2. Depress VAC and any range button.

3. Connect dc voltmeter between shorting links 1, 2, or 3 and common (shield).

4. Short HI to LO INPUT terminals. DC voltmeter should indicate within 100 millivolts of zero.

FAULT ANALYSIS

If indication is incorrect, go to step 6.

5. Remove input terminal short and apply full range voltage at 500Hz. The dc voltmeter should indicate within 0.95 to 1.05 volts.

FAULT ANALYSIS

If indication is incorrect, go to step 10.

6. Remove any INPUT voltage or short. Short TP1 to common (shield).

FAULT ANALYSIS

If dc voltmeter indication changes to within 100 millivolts of zero, go to step 10.

7. Short TP1 and TP2 to common.

8. Connect dc voltmeter high lead to TP4. DC voltmeter should indicate within 100 microvolts of zero and adjustable with R50 (Integrator Amplifier Zero Adjust).

FAULT ANALYSIS

If indication is incorrect, troubleshoot Integrator Amplifier circuit.

9. Remove short at TP2 (maintain short between TP1 and common) and connect high lead of dc voltmeter to TP2. DC voltmeter should indicate within 200 millivolts of zero and be adjustable with R51 (Square Root Amplifier Zero Adjust).

FAULT ANALYSIS

If indication is incorrect, troubleshoot Square Root Amplifier circuit.

10. Remove any input voltage, disconnect dc voltmeter and all shorts.

11. Connect a dc coupled scope with low capacitance probe to the threaded body of C4 (10V 50kHz adjust) and common.

12. With no input voltage applied to 8200A, scope should indicate zero volts. With full range voltage at 500Hz applied to 8200A, scope should indicate a clean sinewave of 2.8 volts peak-to-peak.

FAULT ANALYSIS

If scope indication is incorrect, troubleshoot Range Amplifier circuit.

13. Move scope probe to cathode of CR10 or anode of CR9.

14. With no input voltage applied to 8200A, scope should indicate within 100 millivolts of zero. With full range voltage at 500Hz applied to 8200A, scope should indicate a clean halfwave rectified sinewave of 1.4 volts peak.

FAULT ANALYSIS

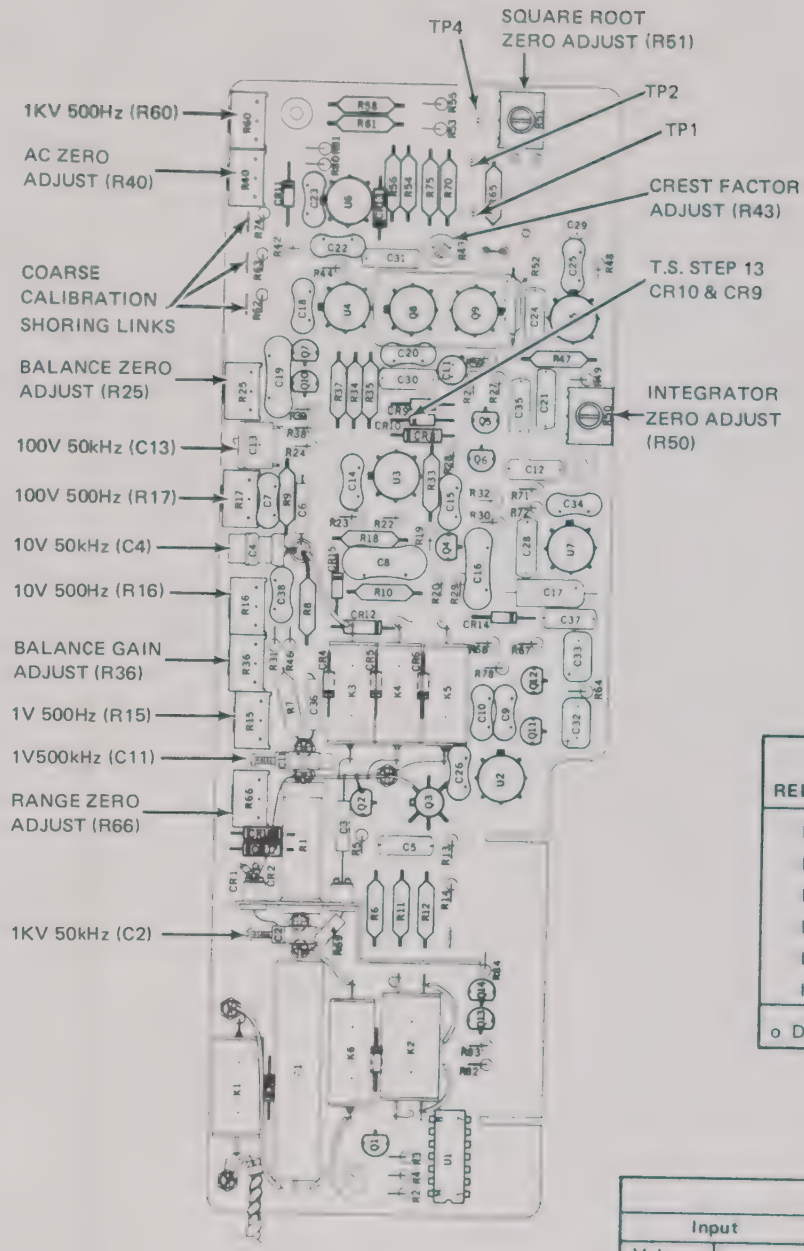
If scope indication is incorrect, troubleshoot Balance Amplifier circuit.

15. Move scope probe to TP1.

16. With no input voltage applied to 8200A, scope should indicate within 100 millivolts of zero. With full range voltage at 500Hz applied to 8200A, scope should indicate approximately −1.2 volts dc with a clean ac scallop superimposed.

FAULT ANALYSIS

If scope indication is incorrect, troubleshoot Squaring Amplifier.



A28
True RMS Converter Troubleshooting Procedure
Drawing No. 8200A-1828

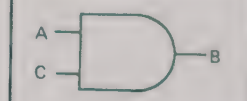
SYMBOL	A	B	C
	0	0	1
	0	1	1
	1	0	1
	1	1	0
LOGIC LEVELS: "1" = High (+5V) "2" = Low (0V)			

Table 1. NAND GATE TRUTH TABLE

RANGE	a	b	a	b
1	1	1	0	0
10	1	0	0	1
100	0	1	1	0
1000	0	0	1	1
LOGIC LEVEL: "1" = High (+5V) "2" = Low (0V)				

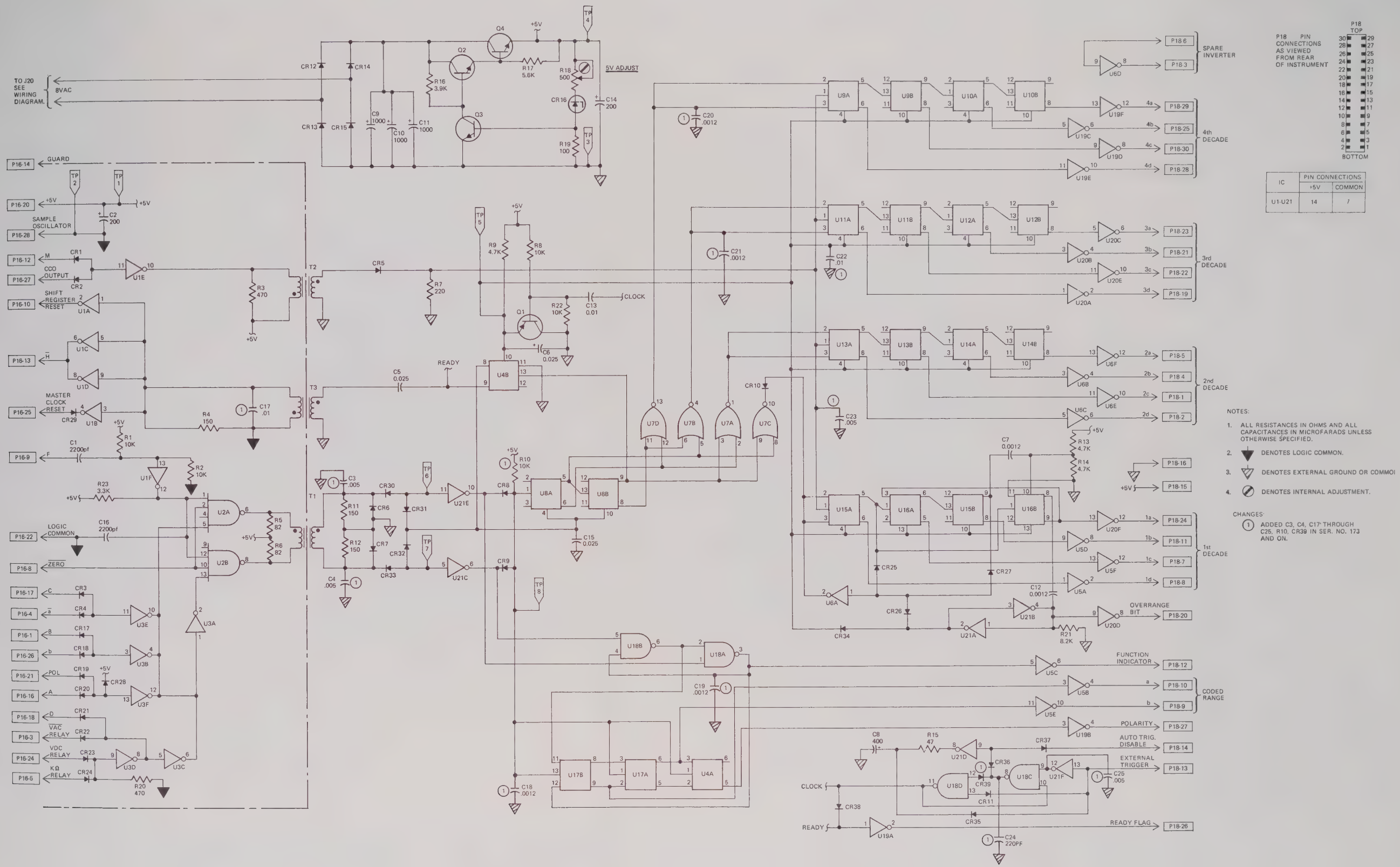
Table 2. RANGE CODE

RELAY	MODEL 8200A RANGE 1	10	100	1000	INPUT COUPLING AC	DC
K1	o	o	o	o		
K2	o	o	o	o		
K3		o				
K4			o			
K5				o		
K6						o
o Denotes Relay Energized						

Table 3. CONVERTER RELAY LOGIC

Model 8200A					
Input		Range	Adjustment	Circuit Designation	Readout (±5 digits)
Voltage RMS	Frequency				
500.0	500Hz	1000	1000VAC 500Hz	R60	500.0
1.0000	500Hz	1	1VAC 500Hz	R15	1.0000
10.000	500Hz	10	10VAC 500Hz	R16	10.000
100.00	500Hz	100	100VAC 500Hz	R17	100.00

Table 4. CALIBRATION CHECK



P18 PIN CONNECTIONS AS VIEWED FROM REAR OF INSTRUMENT

P18 TOP

30 29
28 27
26 25
24 23
22 21
20 19
18 17
16 15
14 13
12 11
10 9
8 7
6 5
4 3
2 1

BOTTOM

IC	PIN CONNECTIONS	
	+5V	COMMON
U1-U21	14	7

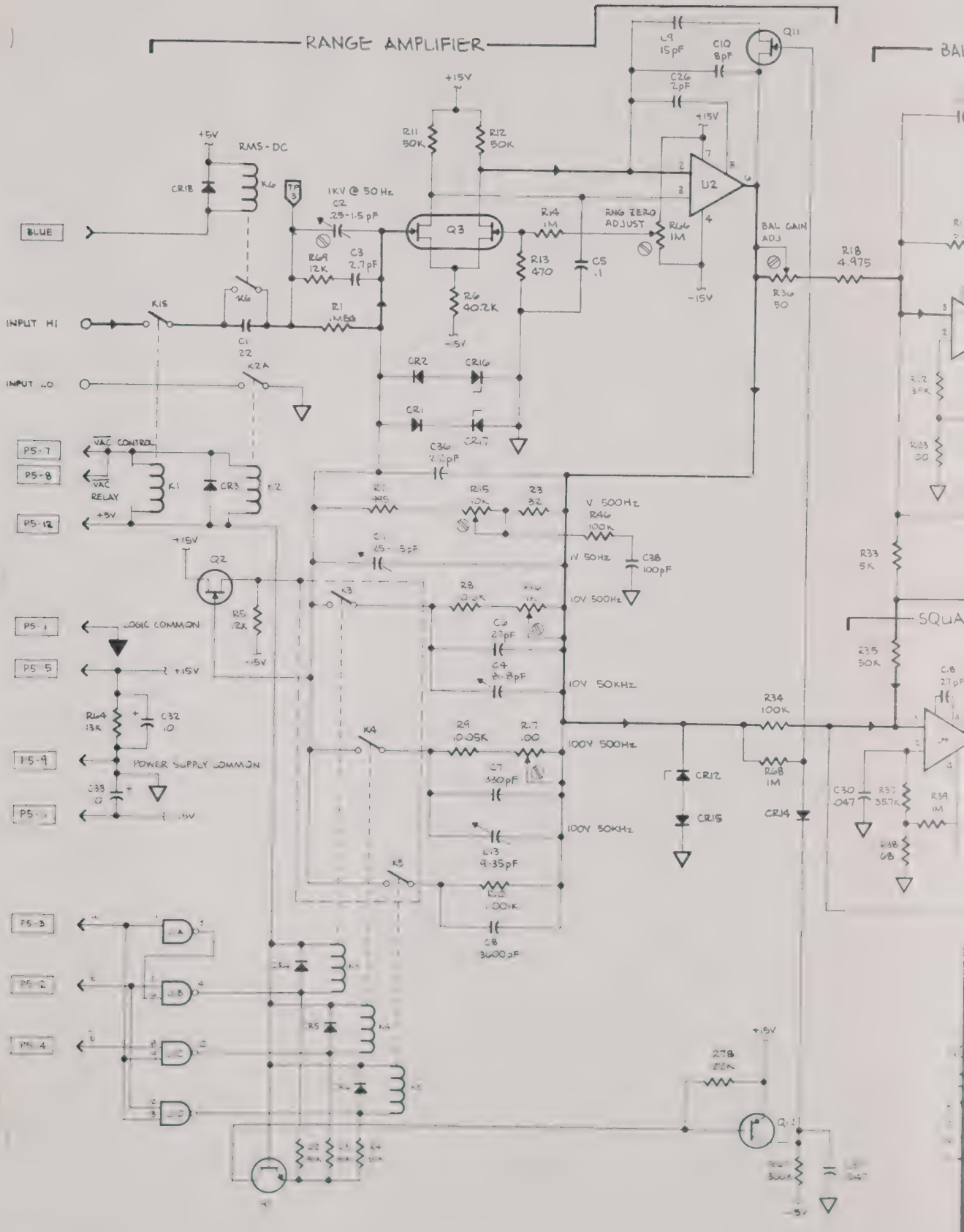
NOTES:

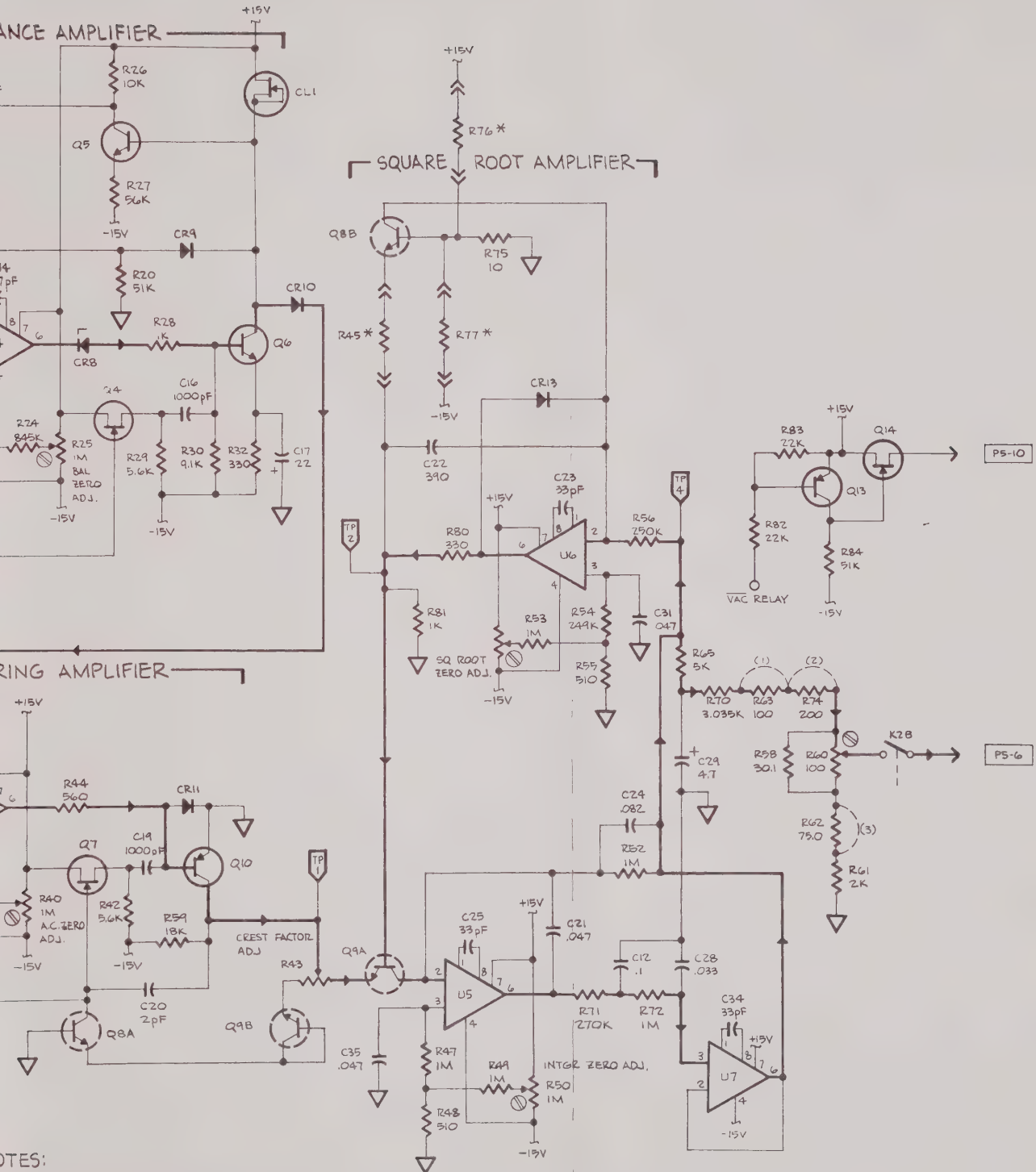
1. ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ▼ DENOTES LOGIC COMMON.
3. ▽ DENOTES EXTERNAL GROUND OR COMMON
4. ⊘ DENOTES INTERNAL ADJUSTMENT.

CHANGES:

(1) ADDED C3, C4, C17 THROUGH C25, R10, CR39 IN SER. NO. 173 AND ON.

A16
PRINTER OUTPUT UNIT
DRAWING NO. 8200A 1016 REV. a


RANGE AMPLIFIER
BLUE
INPUT HI
INPUT LO
P5-7
P5-8
P5-12
P5-1
P5-5
P5-9
P5-11
P5-3
P5-2
P5-4
+15V
-15V
+5V
RMS-DC
CR18
K6
TP3
1KV @ 50Hz
C2 .25-1.5pF
R69 12K
C3 2.7pF
R1 1MEG
C1 22
K1S
K2A
K2
K1
CR3
VAC CONTROL
VAC RELAY
R11 50K
R12 50K
Q3
R14 1M
RNG ZERO ADJUST
R66 1M
R13 470
C5 .1
R6 40.2K
U2
Q11
C9 15pF
C10 8pF
C26 2pF
BAL GAIN ADJ
R36 50
R18 4.975
CR2
CR16
CR1
CR17
C36 220pF
R7 49.9
R15 10K
R3 332
V 500Hz
R46 100K
1V 50Hz
C38 100pF
10V 500Hz
Q2
R5 2.2K
C1 .25-5pF
K3
R8 0.5K
C6 27pF
C4 8-8pF
10V 50KHz
K4
R9 10.05K
R17 100
100V 500Hz
C7 330pF
C13 9-35pF
100V 50KHz
K5
R10 .001K
C8 3600pF
LOGIC COMMON
POWER SUPPLY COMMON
R64 13K
C32 10
C33 .01
R34 100K
R68 1M
CR12
CR15
CR14
R33 5K
R35 50K
C18 27pF
C30 .047
R37 357K
R38 68
R39 1M
SQUA
R28 2.7K
Q21
R30 300K
C34 .047



OTES:

LL RESISTANCES ARE IN OHMS - ALL CAPACITANCES RE IN MICROFARADS, UNLESS OTHERWISE NOTED.

* INDICATES FACTORY SELECTED PART.

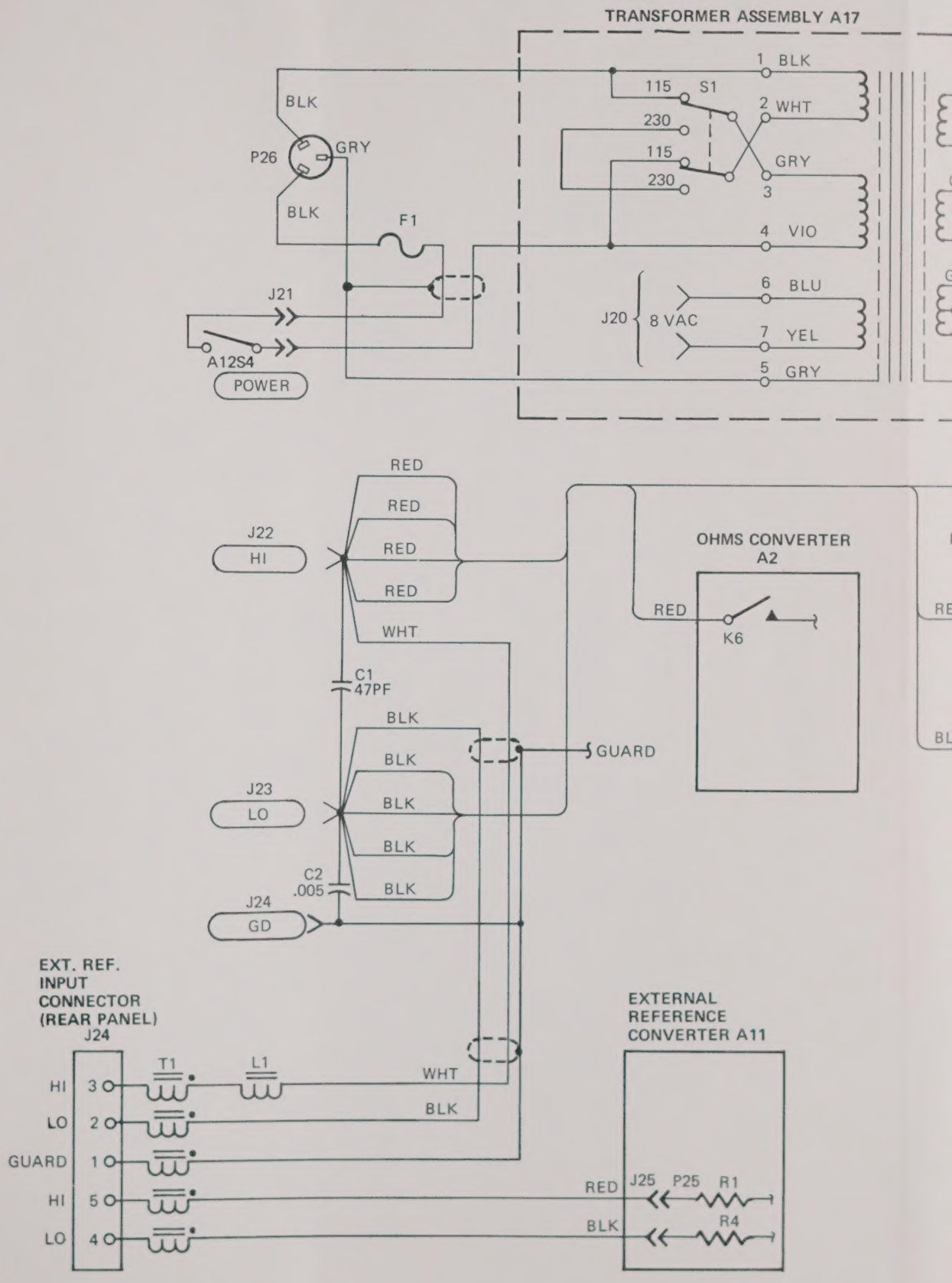
SEE PARTS LIST FOR SERIAL NUMBER EFFECTIVITY.

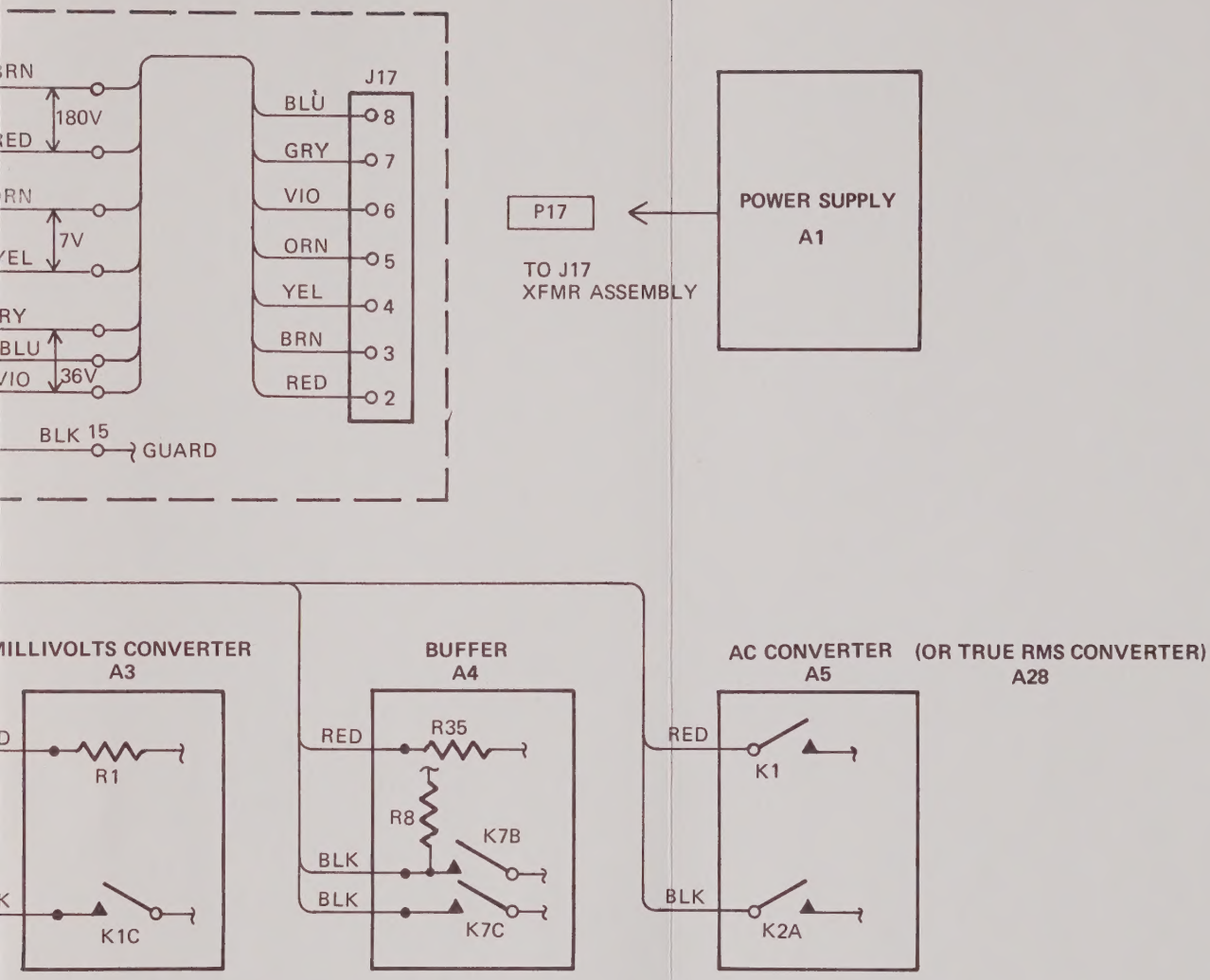
INDICATES INTERNAL ADJUSTMENT.

PRIMARY SIGNAL PATH

A28
TRUE RMS CONVERTER

8200A—1028


TRANSFORMER ASSEMBLY A17
1 BLK
115
S1
2 WHT
230
115
230
GRY
3
4 VIO
6 BLU
J20
8 VAC
7 YEL
5 GRY
BLK
P26
GRY
BLK
F1
J21
A12S4
POWER
RED
RED
RED
RED
J22
HI
WHT
C1
47PF
BLK
BLK
GUARD
J23
LO
BLK
BLK
BLK
C2
.005
J24
GD
OHMS CONVERTER
A2
RED
K6
EXT. REF.
INPUT
CONNECTOR
(REAR PANEL)
J24
T1
L1
HI 3
LO 2
GUARD 1
HI 5
LO 4
WHT
BLK
EXTERNAL
REFERENCE
CONVERTER A11
RED
J25
P25
R1
BLK
R4



NOTES:

1. ( ) DENOTES FRONT PANEL LOCATION.

CHANGES:

(1) ADDED T1, L1, C1, C2
IN SER. NO. 530 AND ON.

WIRING DIAGRAM AND
INPUT POWER SCHEMATIC
DRAWING NO. 8200A-1000 REV. a

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